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Superhighway Development in the Milwaukee Metropolitan Area

How Milwaukee County Is Caring for Its Heavy Traffic

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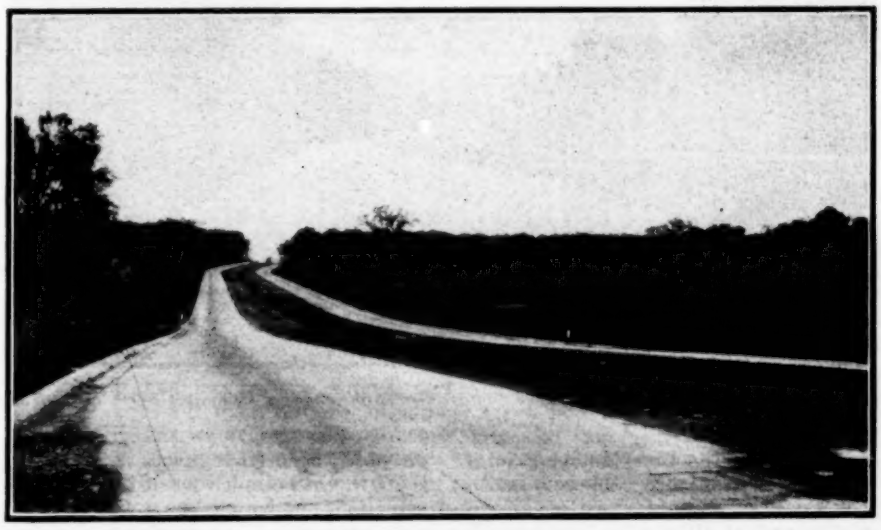
WHEN one speaks of a superhighway, there is at once formed in the listener's mind a vision of a wide, smooth highway constructed to take care of an extraordinary number of vehicles at great speeds with comparative safety. It is a creation caused primarily by increased automotive transportation and cultural development, such increase being most noticeable in the vicinity of large centers of population.

The Traffic Problem of Milwaukee County.—In Wisconsin, about 35 per cent of the population is to be found in a limited number of counties in the southeastern section and Milwaukee, the largest city in the state, is practically the nucleus of this comparatively congested area. Milwaukee can practically be called the gateway of the state. In the quadrant between north and west are to be found some of the largest cities of the state, all of which are served by highways which radiate from the metropolis. In this same area are hundreds of picturesque lakes to which transportation must be furnished, not only for our own people but also for the thousands of out of state visitors who come annually to enjoy the beauties and pleasures which Wisconsin affords. To the south lie Racine, Kenosha and Chicago, with the thickly populated areas which surround them. The highways connecting these centers of population are used not only for pleasure but for business and for the transportation of freight and the necessities of life. Therefore, it can be readily seen that because of its geographical location Milwaukee County has a grave problem to solve in taking care of the tremendous volume of traffic which it must serve.

All Main Highways Have Established Widths.—The county board, some years back, foreseeing conditions and realizing that some initiative should be taken, established a regional planning department under the jurisdiction of the highway committee, one function of this department being to study highway needs. After considerable investigation, they submitted a report recommending that set-back lines be established on certain highways in widths ranging from 90 ft. to 160 ft. to take care of future highway requirements. These highways are laid out so that in the future as development progresses traffic will be able to enter, leave, or circle the city of Milwaukee and the surrounding area at the greatest possible speed with a minimum amount of confusion and congestion. The board, with the aid of state legislation, wisely accepted and passed on this report, and, as a result, all main highways in the county have now established widths considered suitable for future needs. This does not mean that any right-of-way is being purchased at the present time, but means that any new developments must be kept back a prescribed distance from the centerline so that when the highways are widened only land will be obtained and the difficulties of moving or purchasing buildings will be eliminated. It also means that in the case of new subdivisions the necessary street width must be provided before the plat is accepted. Ozaukee County, directly to the north, has taken action establishing the same widths as those for connecting highways in Milwaukee County. Counties to the south and west have as yet taken no definite action along these lines, but some favorable reaction is taking place and we believe that within a comparatively short time the same system will be inaugurated in these counties.



Blue Mound Superhighway in Waukesha County, Wisconsin, Showing Completed North and South 20-Ft. Units. Future Widening Will Be Done by Additional Pavement on the Inside

The Blue Mound Road.—As in the case of every metropolitan area, there is always one highway which, from a traffic viewpoint, predominates above all others. In Milwaukee County, this road is the Blue Mound Road, also known as U. S. Highway No. 16. This famous road is probably the first east and west road through the state, beginning at the heart of the city and running through the wonderful lake region of Waukesha County, the state capital and terminating at historic Prairie du Chien on the banks of the Mississippi.

While no definite early traffic counts

are available, its importance can be visualized by the fact that as early as 1913 the county paved this highway from the city of Milwaukee to the west county line with 18 ft. of concrete. The increase in traffic was steady, so much so that in 1923 a count showed as high as 9,337 vehicles, of which 9,158 were automobiles, 175 were trucks and 4 were horse-drawn.

Parallel Road Constructed.—Realizing the rapidity of increased traffic, it was decided to provide another outlet for westbound traffic by building a parallel highway on Greenfield Ave., a mile south of the Blue Mound Road, to the city of Waukesha, the county seat of Waukesha County, which lies directly west of Milwaukee County. The theory was that the traffic would divide and each road would take its share, thus minimizing congestion. This assumption, however, was not borne out by actual conditions which existed upon the completion of Greenfield Ave. Results of a traffic count in 1925 gave 7,500 vehicles on this highway and 16,130 on the Blue Mound Road, indicating that the traveling public favored the latter highway, Greenfield Ave. serving more or less localized traffic. This same congestion on the Blue Mound Road existed in Waukesha County as far as a place called Goerke's Corner, a fork in the road, where U. S. 16, U. S. 18, and State Highway No. 30 joined at a common point, 8.6 miles west of the limits of the city of Milwaukee. The surfacing on the highway at this time was 3.6 miles of 18-ft. pavement in Milwaukee County and 2.0 miles of 24-ft. tar macadam and 3.2 miles of 20-ft. concrete pavement in Waukesha County.

Blue Mound Superhighway in Milwaukee County, Wisconsin, Showing Completed North and South 20-Ft. Units

Providing for Four Lanes of Traffic.—With the above in mind, it was plainly evident that additional accommodations would have to be provided by furnishing additional roadway width. It was decided to provide for at least four lanes of traffic by building 40 ft. of pavement, but the best method as to how this was to be accomplished required considerable thought and investigation. Naturally, the first thought was to widen the present pavement and build other portions to 40 ft., but a study of such construction in our own county and in the vicinity of a large metropolis showed that, unless perfectly policed and properly regulated, the traveling public does not get the benefit of the full width of roadway provided for it. If each vehicle kept to its proper lane according to the theory on which a 40-ft. highway is designed, there might be much merit in such construction, but we all know what a difficult matter it is to teach the general public its proper place on the highway. On single width pavements there is a general tendency to keep toward the center, leaving an unutilized space toward the right, or it is not uncommon to see cars driven over the dividing markers rather than to one side, thereby appropriating practically two traffic lanes. Then, again, it has been found that there is a greater feeling of security in passing a vehicle at high speeds than in meeting it. We found that on single width roadways a hazardous condition is created at night, where the headlights of the oncoming cars blind the driver of the car approaching from the opposite direction, causing him to veer to the side, thus decreasing the efficiency and available width of the roadway.

As stated before, with stringent policing both as to speed control and traffic regulations some of these objections could be overcome but we have noticed that even on wide pavements within the cities, where such control is most favorable, it is practically impossible to obtain the carrying capacity for which such pavements were designed.

Divided Roadway Selected.—Considering the foregoing objections, and having in mind that they are practically eliminated with divided roadways, the ultimate section decided upon for our superhighways was one patterned after those in Wayne County, Michigan. This consists of two pavements, each 40 ft. in width, with a curb and gutter on each side separated by a parkway ranging in width from 10 to 50 ft. This parkway will serve as a distinct dividing area for contradirectional traffic. In strictly zoned areas or on highways where the condition of the present pavement does not warrant salvage, sufficient right-of-way will be obtained from each side to give the required width. In the case of comparatively new construction where alignment and grades are satisfactory and the pavement has considerable value, right-of-way will be purchased on one side. Both of these conditions were met in the construction of our first superhighway as will be shown later.

Ultimate Section Provides for Two 40-Ft. Pavements.—A section such as described above was designed for the Blue Mound Road on which a right-of-width of 120 ft. was established. The ultimate section provides for two pavements 40 ft. in width separated by a parkway 10 ft. wide, allowing 15 ft. on each side for sidewalks. It was estimated that 40 ft. of pavement, providing for four lanes of traffic, would take care of our needs for some time so the two inside units were constructed first. These consist of two 20-ft. pavements with curb and gutter along the outer edge, leaving a parkway 50 ft. in width separating the slabs. As necessity demands widening will be done toward the inside, possibly in ten-foot increments, until the ultimate section is constructed.

Inasmuch as both the grade and alignment were not in keeping with future needs, new grades and lines were established in cooperation with the regional planning department and the City of Wauwatosa with a view toward meeting urban requirements. This necessitated the removal of all of the old pavement in Milwaukee County. In Waukesha County, a 20-ft. concrete pavement constructed in 1922 was still in good condition, so all of the right-of-way was purchased on one side to conform with the general idea of the ultimate section. In the Village of Goerke's Corners and a portion of the City of Wauwatosa, however, the general plan could not be allowed. It happened that in both of these towns sections were so developed and built up that with the funds available it was practically impossible to secure the necessary right-of-way. Therefore, a portion in the City of Wauwatosa 1.06 miles in length was built full width, 60 ft. from face to face of curb, and at Goerke's Corner 0.87 of a mile of the existing 20-ft. pavement was widened to 40 ft. The transition from the full

widths to the double lanes was made with long easy curves so that the change from one to the other is practically unnoticeable.

Drainage was taken care of by providing spillways along the sides from openings in the curb except on the full width portions where sewer facilities were available. The center of the 50-ft. parkway was built 1 ft. lower than the pavement and suitable drop inlets were constructed over culverts to take care of the water accumulating in this area. However, as the country develops and becomes built up, it may be found necessary to construct a system of storm sewers to take care of the rainfall.

In connection with the construction of this superhighway, a grade separation structure over the Chicago & Northwestern Ry. was built. In keeping with the general plan, this structure, 132 ft. in length, has a roadway ninety-two feet wide with a ten-foot sidewalk on each side.

A grade crossing over a cut-off freight line of the Chicago, Milwaukee, St. Paul & Pacific Ry. in Waukesha County still exists due to lack of funds necessary to effect a separation at the time of construction. Grades on the superhighway have, however, been laid with a view toward a separation which it is hoped can be accomplished in the very near future.

Divided Pavement Design Flexible.—The flexibility of divided pavement design is self-evident. Once the full right-of-way has been obtained, construction can be carried out in whatever manner is most desirable. Depending upon traffic needs, either single or double units can be built so as to form a nucleus for the ultimate section. Once these are completed, future expansion can be effected without closing the road. As an example of how this method was carried out in Milwaukee County, we can cite the work done on Capitol Drive, State Highway No. 119. This is an important highway near the north limits of the City of Milwaukee, beginning at Lake Michigan in the Village of Shorewood and extending westerly to the Village of Pewaukee in Waukesha County. It forms a much needed artery for distributing northbound traffic for points within the city and also affords a route for avoiding city congestion.

In 1925, it was desired to improve a portion of this highway, and being in the zoned area, a section much similar to that described for the Blue Mound Road was developed. However, traffic needs at the time did not warrant the construction of more than a two-lane roadway. Right-of-way for the ultimate section of 130 ft. was obtained, but only the center 20 ft. of the north 40 ft. were constructed. Traffic, due to cultural development, has since increased to such an extent as to justify additional pavement, so this year we contemplate the construction of the center 20 ft. of the south unit, leaving a parkway of 30 ft. between slabs. Shoulders are provided along the outer edges and drainage is being taken care of by open ditches until such times as conditions warrant a higher type of construction. Additional traffic lanes will be provided for in the future by placing a 10-ft. lane with curb and gutter on each side of the 20-ft. unit, leaving a 10-ft. parkway between pavements.

Other Superhighways.—Another very important highway is the Kilbourn Road, U. S. 41, south from Milwaukee. This highway forms a connecting link in the Three States Superhighway traversing Wisconsin, Illinois, and Indiana. This superhighway is so laid out as to afford ready access to, but avoids all large centers of population, and will, no doubt, in time become one of the most heavily traveled arteries in this section of the country.

A 4-mile project south from the city is now being developed for construction in 1930. On this highway, zoned at 150 ft. the ultimate section provides for two pavements 40 ft. wide separated by a parkway 50 ft. wide. It can be readily seen that while we contemplate providing for only four lanes of traffic in one direction, the design is such that if required six lanes can be ultimately obtained at comparatively small expense. In this case, 10 ft. of parkway would still intervene. At the present time, it is the intention to construct the two inside 20-ft. units, providing 10-ft. graveled shoulders on the outside and taking care of the drainage in open ditches. This, we believe, will take care of our needs for some time to come.

You will note that in rural communities or in sections where culture does not make the cost prohibitive, we insist on separating pavements to provide for one direction traffic. Observation of traffic conditions on our latest development has borne out our theories and we believe that we are solving some of the traffic problems with which we are faced. The Blue Mound Road today is carrying more traffic than it ever has before. A count taken midway between Wauwatosa and Goerke's Corner last Fourth of July showed an excess of 16,000 vehicles moving along at great speeds without confusion, without congestion, and without accidents.

Our traveling public is well pleased with freedom of movement which this type of highway affords and are asking that more of this kind of construction be carried out on heavily used arteries. Having in mind that only a comparatively short time ago it was not uncommon to arouse unfriendly criticism and numerous objections in spending large sums of money in the development of single highways, we consider the favorable comments we receive a reward for our efforts.

Acknowledgment.—The foregoing is a paper presented July 11 at the Milwaukee convention of the American Society of Civil Engineers.

Eighth Annual Paving Conference

The Eighth Annual Asphalt Paving Conference, which will be held Oct. 28 to Nov. 1, next, at West Baden, Ind., under the auspices of The Asphalt Association, New York, will be of transcendent importance among road meetings this year, according to officials of The Asphalt Association, on account of the fact that the improvement of farm-to-market roads will be the keynote of the meeting. Airport paving will also be given serious attention, along with city street construction and trunk-line highway improvement. The dominant feature, however, will be the discussions as to the latest and most economical methods evolved for the construction with asphalt of low-cost surfaces on the secondary and tributary highways. Salvaging of existing gravel and macadam roads and their utilization as bases for low cost asphalt surfaces will receive important consideration as one of the measures figuring heavily in any farm-to-market, road paving program.

The Association of Asphalt Paving Technologists will hold its annual meeting in connection with the conference. The sessions of this organization, alternating with those under the auspices of The Asphalt Association, will provide discussions pertaining to the technical side of asphalt construction and affording research information of great value to the technical men in attendance. W. J. Emmons of Ann Arbor, Mich., and C. A. Mullen of Montreal, Canada, this year, are president and secretary, respectively, of the Association of Asphalt Paving Technologists.

Elaborate entertainment features will be provided during the conference, the attendance at which is expected to surpass that of the 800 registered at the New Orleans meeting last year.

Progress of Highway Construction in Peru.—The Government of Peru continues to carry on an extensive campaign to maintain the public interest in the variety of undertakings being financed by the central authority, according to a report from Ambassador Alexander P. Moore. Great progress has been made on the coast road the length of Peru from Tumbes on the north to the border of Tacna on the south. It is stated that, with the recent completion of a difficult pass over one of the Andean spurs which juts into the Pacific, north of Lima, and several short sections south of Mollendo, this highway is now open to traffic along its entire distance of approximately 1,300 miles. However, several bridges remain to be built over streams at present passable except during the rainy season in the Andes (January to April). It will be added that the entire highway will require several years before its condition could even remotely equal that of a main artery of travel in the United States.

The Highway As Part of Our National Transportation System

An Outline of the Past, Present and Future of Highways

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THERE have been great changes in modern transportation in the 15 years that have elapsed since the first one of these meetings of this group at Ann Arbor. There have been equally marked changes in the subjects which have been discussed and the problems which have had consideration.

Transportation—a Constant Change.—Every now and then someone lets me have inside information to the effect that we are in a period of transition in the matter of transporation. As a matter of fact there has been constant change, continuous development, in transportation during our whole national life. These changes have been kaleidoscopic—complete. Every few years finds a new conditon as to transportation.

From the utter lack of adequate internal transportation in colonial days, when the ocean bays and coastal rivers furnished the only highways of commerce, to the development of primitive transportation on the interior rivers and the Great Lakes, was but a step. Then came the canal period, and the construction of several thousand miles of canal was begun.

The Steamboat Era.—The early steamboats on the Ohio and Mississippi in 1810 to 1815 marked the beginning of an era. This was perhaps the most interesting and picturesque form of transportation that has yet prevailed, reaching its peak of prosperity in the years immediately following the Civil War.

The canals are gone, and are but a faint memory of old men. The steamboat days have likewise passed, except for a very small number of tow boats operating the barge lines.

The electric interurban railway is another type of transportation, much more recent, that bids fair to soon become nothing but a memory.

The Coming of the Railroads.—The railroad, first appearing in 1830, proving its worth as a carrier and its capability for good earnings, in the period from 1840 to 1860, has undergone continuous change and development. It drove out the canals and destroyed the traffic of the river steamboat. The railroads spread all over the continent, and made possible the settlement of the interior and the development of industry. Evils and abuses that resulted from the early period of railroad promotion and speculation resulted in the war against, and ultimate regulation of railroads, in steadily decreasing rates, and, most important of all, in a development and improvement of both equipment and road that is nothing short of marvelous.

While the transportation on our canals and rivers decreased water transportation on the ocean and Great Lakes made great strides forward. The Great Lakes commerce has grown about as rapidly as railroad traffic has grown, and we may confidently expect that just as fast as business demands it and as traffic grows to support it, our internal waterways will be developed as a major agency of American transportation.

The Highways Come Into Their Own.—Change and development has not been limited to rail and water transportation. The highways did not come into their own until recently, but there always has been recognition of their importance. The building of national roads a hundred years ago, the development of toll roads, then pikes and plank roads 60 to 70 years ago, the bicycle period of 30 to 40 years ago, and the recognition of the need for proper and durable types of pavement in cities in the years following the Civil War, were all steps in the path of progress.

The automobile was invented and developed in the period 1890 to 1910 and more strongly than anything else pointed out the need for better roads in country as well as city.

During this period a good many men in different parts of the country assumed the role of John the Baptist and preached the coming of good roads.

The Great Changes in the Transportation Business.—The automobile and the good roads have brought about the greatest and most sweeping changes in our transportation business that have yet come. These changes may be summarized as follows:

1st. The development of private transportation and the abandonment by a large part of the population of certain uses of public transportation agencies.

2nd. The consequent change in steam railroad passenger business from short haul local business, the old day coach traffic, to long distance Pullman car traffic. This has been well nigh fatal to the passenger business of the short line carrier like the Ann Arbor Railroad.

3rd. The development of automobile truck business which will undoubtedly take much of the less than car load, short haul business from the railroads. This is not a loss for the railroad. It is business of doubtful profit, and its loss is more than made up by the fact that the truck as a feeder and distributor for the railroad brings more than it takes away.

4th. The electric railroad between cities, which never did develop much freight business, has lost its passenger business to the privately owned automobile. The interurban railroad is a very sick industry.

The Future of the Highways.—In considering the highway as a part of our national system of transportation, it seems to me that the kaleidoscope has turned sufficiently to let us get some conception of the form of the coming picture.

Highway engineers are transportation engineers and must so consider themselves. Just as much so as members of the engineering staff of the railroads. In dealing with American transportation it is absolutely essential to keep in mind the tremendous increase in volume of business which has taken place since 1900. Statistics of all industries show an increase in the volume of production of from 100 per cent to 400 per cent in different industries.

There is nothing to indicate that we have reached our limit. We may safely plan for more business, larger production, a greater demand for transportation, larger cities, a continuance of the higher standards of living that have developed. It is our job to look into the future and to plan, so far as possible, not for the needs of today or next year, but for those of 10 or 20 years ahead.

Coordinated System of Transportation.—I think that we may safely assume that the American transportation system of the future must be a coordinated system in which railway, highway and waterway each takes its proper part.

The American nation owes its character, indeed the very existence of large portions of it, to the railroad. In no other country in the world will be found great and prosperous cities far from navigable water. This country cannot exist without the railroad as the carrier of heavy burdens over long distances.

In 1927 American railroads moved 471 billion ton miles of freight. That was an increase of 100 billion ton miles over 1911.

That is 1,340,000,000 ton miles each day. If that business were moved by trucks, each carrying 10 tons and each traveling 200 miles per day it would call for 670,000 trucks, to be constantly on the move. If time for loading and repairs be estimated, and the light loads and empty runs be allowed for, it would mean about two million 10-ton trucks or five million 4-ton trucks to do the business now done by the railroads.

The railroads received for that business less than one and one-tenth cents per ton mile. The very best records of cost by truck are such that the American freight bill would be increased from 75 to 100 million dollars a day over what it is now if it had to be handled by truck alone.

These figures are of such magnitude that it is perfectly obvious that neither truck, nor airplane, nor any other agency that we now know of or conceive can displace the railroad as our chief beast of burden, and it is our duty to ourselves to see to it that nothing is allowed to happen which will injure or weaken this essential agency of transportation.

The Part of the Waterway.—The waterway can move bulky, low cost freight more cheaply than the railway. Sound waterway development will not only not injure the railways but will strengthen them. As proof of this study the water traffic on the Great Lakes and the resulting development of adjacent and tributary areas, and the railroad growth in that area. The moving of bulky low value freight must of necessity be done at a very low cost. Such development as that of the iron mines in Minnesota and Michigan could never have reached its present volume if dependent on rail transportation. The other business created by this development has caused the railroads to profit immensely, even though they could not handle the ore.

Waterway development will increase in coming years and will be of value not only as a stabilizer and regulator of rates, but as a developer of areas which are now behind the times, and which can only grow as cheap rates permit the full exploitation of natural resources.

The highway is the ally of both railway and waterway. Short haul freight and passenger business, and much of the travel for pleasure, which has in the past used other agencies will go to the highways. In addition the almost inconceivable number of highway movements which are solely due to modern motor development and to good roads and which have no relation to railroad or water traffic, is enough in itself to test our skill to the utmost to provide for it.

Definite Things That Must Be Done.—It appears to me that those transportation engineers of the present and future who are dealing with the highways have certain very definite things which must be done. Especially here in Michigan, where we have one of the great cities of the country, and where we have a wonderful asset of playground and summer climate.

There must be a recognition of the need for wider trunk line highways in the future than are now being built, and the time to secure land for future development is now. There is now a general recognition of the fact that the building of a good paved road adds materially to adjacent land values. It seems to me that the adoption of a policy which will require land owners to deed to the public sufficient land to provide from 100 to 150 ft. on main roads and not less than 80 to 100 ft. on secondary roads which are being paved, would be sound and right.

Furthermore the public should not permit abandoned electric railway rights of way, especially where alongside highways, to revert or be sold for other purposes. These are generally alongside trunk line roads. Forty years' experience tells me that right of way can be acquired before an improvement at a small fraction of what it will cost after the improvement is done.

The trunk line highway, like the trunk line railway, must outgrow its single track and its cheap construction. Just as the trunk line railroads are adding second and third main tracks, using heavier construction and equipment, and making every provision for safety, the trunk line highways must plan to grow.

Park Development.—No one has seen the splendid work of the Westchester Park Commission in New York, and the perfectly wonderful development which follows the actual road construction, can fail to appreciate the great possibilities here in Michigan. Such counties as Washtenaw, Oakland and Livingston can well afford to commence right now to plan a system of county parks and parkway development for a 20-year program. Such work as that of the Washtenaw Commission in the Huron River Drive is not only praiseworthy, but it ought to be extended by the acquisition of ample rights of way and of public picnic grounds and parks over many hundreds of miles of stream side and lake country in the three counties named. Get the land now. Make the plans and get the land while free or cheap. Once the land is acquired the good folks will give you the money to develop it. From the purely selfish viewpoint of personal profit to our citizens it will pay largely. To those of us whose hind sight goes back 50 years, it is perfectly obvious that the universal use of the roads for pleasure will continue even if its increase be less rapid in the future, and the sooner we take steps to get the passenger vehicle out for an afternoon off from the trunk line the better it will be for all.

Separation of Grades.—Do not permit any new railroad lines, or extensions of existing lines that do not make full provision for the separation of grades with existing roads which are now or are likely to become main thoroughfares, and at the sole expense of the railroad.

When main highways are being improved, especially when location is being revised, attempt to separate the grade of all railroad crossings.

I cannot over emphasize the importance of this matter of grade separation. It has been my privilege to serve for two years as the representative of the American Engineering Council on the Committee on Grade Crossing Elimination and Protection. For the past three years grade crossing accidents have approximated 6,000 per year. In 1926 2,492 lives were lost, in 1927 about the same number. In the first four months of 1927 668 passengers in motor vehicles were killed at crossings while only 2 passengers on railroads were killed in all kinds of accidents. In the same period 200 passengers on railroads were injured and 2,900 were injured at grade crossings.

Just as the railroads have spent many millions of dollars for block signals, for interlockers, and for train control, both railroads and the public must proceed to spend many millions more to abolish grade crossings whenever practicable. It has been estimated that it would cost 18 billion dollars to separate all grade crosings. This cannot of course be done, but there are thousands of crossings that should be and will be in time changed to grade separation.

I have never seen any accurate or reliable list of killed and injured in the daily use of the highways. We all know that the need for grade separation is not confined to the railroad crossings. Such splendid work as that of the Wayne County Commission in highway grade separation, and in the rearrangement of intersections so as to reduce the hazard of the cross road, is work that will increase greatly as years go by. It strongly emphasizes the necessity for trying to see into the future, and so planning that when these things have to be done there will not be the necessity of moving a lot of buildings and buying costly land.

Highway building has proceeded along the same historical lines that railway building has done. The things of early years were done cheaply and sufficed for the light traffic. As certain lines developed into trunk lines there came the need for revised location, better construction, greater capacity for service.

The Highway Is No Longer Unimportant.—Cheap politics can no longer deal with the problems presented. A density of traffic undreamed of a few years ago. The use of the roads by everybody, sober or drunk, sane or crazy, experienced and careful, or ab-

sent-minded and the merest novice, makes the problem of the operating officials infinitely harder than those of the railroad.

In closing may I not venture the hope that we may have within the next three or four years, laws which will give our county highway commisioners authority over parks and parkways, and not only permit, but authorize the making of comprehensive and complete plans for highway and park development in each county, and further to so provide for inter-county cooperation and general supervision of the state commission, that all such plans will fit together, to constitute an ideal system of highways? Such a system might properly permit the taking up of some lines of run-down and unprofitable railroad which can no longer serve, and should provide for Michigan a thoroughly ample and adequate system of transportation to meet all needs.

Acknowledgment.—The above paper was presented at the 15th annual conference on Highway Enginering at the University of Michigan.

Determining Benefits of Proposed Improvement

Economic Analysis Shows Excess of Benefits Over Costs

By MANTON HANNAH
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IN presenting the final arguments to establish the need for improvements of the state highways in McLennan County, Texas, there was set up what was termed an economical analysis which, reduced to its lowest terms, means the excess of the benefits over the costs, on a 40-year basis which gives the net value to be received.

Basis for Determining Benefits.—In this instance, at the outset, a county-wide traffic census, taken over a period of 7 days showing 7,375 vehicles each 24 hours, was used as a basis of determining the benefits to be derived; first, from shorter routes, and, second, from improved road surface conditions.

It was found possible to shorten the distance traveled by each vehicle 1.3 miles and this capitalized on the basis of 5 ct. per mile the cost of traveling over smooth concrete, is as follows:

Per mile	: 7,375 x .05	: $ 368.75
Daily	: $368.75 x 1.3 mi.	: 479.38
Annual	: 479.38 x 365 days	: 174,973.70
40 years	: 174,973.70 x 40 yrs.	: 6,998,948.00

This means simply that an investment of practically 7 million dollars would be paid back to present day traffic during the 40-year period.

The road surface conditions in McLennan County were found to be very rough due to the age of the older roads and to character of construction of those built in later years. Based on a cost of 5 cts. per mile for a vehicle traveling on a smooth concrete it was estimated that it would cost 20 per cent more on the highways in McLennan County in their present state.

Traffic Savings From Paving.—Now then if these roads were rebuilt and paved with concrete there would result a saving of 1 ct. per vehicle mile and the average length of each of the eight highways was 19.64 miles. This is a true saving which can and should be made and if so the capitalization would develop the following savings:

Per mile	: 7,375 x .01	: $ 73.75
Daily	: $73.75 x 19.64 mi.	: 1,448.45
Annual	: $1,448.45 x 365 days	: 528,684.25
40 years	: $528,684.25 x 40 yrs.	: 21,147,370.00

Summarized, these savings amount to annually $703,657.95 and on a 40-year basis would justify an investment of $14,073,159.

A study of the savings as applied to each individual road is slightly at variance with the above due to the differences existing between the individual roads as regards length, traffic and distances saved.

Benefits of the Improvement.—In determining the total cost of the improvement the initial investment is taken and carried through the amortization period of 40 years which gives practically double the initial investment. The upkeep cost on concrete roads properly built in the first instance was estimated at three hundred dollars per mile per year and this expenditure likewise carried through the 40-year period. Familiarity with these calculations is so universal that it is not necessary here to go into detail.

Benefits of Improvement

Highway No.	Traffic	Shorter Routes Saved	Shorter Routes Annual	Shorter Routes 40 Years	Road Surface Miles	Road Surface Annual	Road Surface 40 Years	Totals 40 Years
2 N	1,348	0.00	0.00	0.00	18.34	90,235.30	3,609,412.00	3,609,412.00
2 S	1,103	1.21	24,356.45	974,258.00	19.67	79,190.40	3,167,616.00	4,141,874.00
6	1,486	.39	10,577.70	423,108.00	14.83	80,599.30	3,223,972.00	3,647,080.00
7 E	503	1.19	10,924.45	436,978.00	16.18	29,707.35	1,188,294.00	1,625,272.00
7 W	795	2.46	35,689.70	1,427,588.00	24.23	70,309.95	2,812,398.00	4,239,986.00
31	536	.71	6,945.95	277,838.00	17.02	33,298.95	1,331,958.00	1,609,796.00
44	880	.05	803.00	32,120.00	11.13	35,748.10	1,429,924.00	1,462,044.00
67	724	1.41	18,629.60	745,184.00	17.86	47,198.15	1,887,926.00	2,633,110.00
Total	7,375	7.42	107,926.85	4,137,074.00	139.26	466,287.50	18,651,500.00	22,968,574.00

Economic Analysis

Highway	To County Initial Investment	Benefits Total, 40 Years	Costs Total, 40 Years	Excess Benefits Over Costs 40 Years
2 N	644,924.50	3,609,412.00	1,556,096.00	2,053,316.00
2 S	632,133.70	4,141,874.00	1,524,483.40	2,617,390.60
6	691,300.50	3,647,080.00	1,886,640.00	1,760,440.00
7 E	698,472.50	1,625,272.00	1,642,141.00	Loss 16,869.00
7 W	856,938.50	4,239,986.00	2,020,940.00	2,219,046.00
31	647,509.50	1,609,796.00	1,480,539.00	129,257.00
44	372,746.00	1,462,044.00	921,033.00	541,011.00
67	746,548.00	2,633,110.00	1,710,441.00	922,669.00
Total	5,290,573.20	22,968,574.00	12,742,313.40	10,226,260.60

Costs of Improvement

Highway No.	Miles	Construction In Waco	Construction In County	Construction Total	Construction 40 Years	Maintenance Annual	Maintenance 40 Years	Total 40 Years
2 N	18.01	25,063.50	644,924.50	669,988.00	1,339,976.00	5,403.00	216,120.00	1,556,096.00
2 S	18.81	17,248.00	632,133.70	649,381.70	1,298,763.40	5,643.00	225,720.00	1,524,483.40
6	14.99	162,079.50	691,300.50	853,380.00	1,706,760.00	4,497.00	179,880.00	1,886,640.00
7 E	14.90	33,198.00	698,472.50	731,670.50	1,463,341.00	4,470.00	178,800.00	1,642,141.00
7 W	22.13	20,751.50	856,938.50	877,690.00	1,755,380.00	6,639.00	265,560.00	2,020,940.00
31	15.46	0.00	647,509.50	647,509.50	1,295,019.00	4,638.00	185,520.00	1,480,539.00
44	11.08	21,290.50	372,746.00	394,036.50	788,073.00	3,324.00	132,960.00	921,033.00
67	16.54	9,432.50	746,548.00	755,980.50	1,511,961.00	4,962.00	198,480.00	1,710,441.00
Total	131.92	289,063.50	5,290,573.20	5,579,636.70	11,159,273.40	39,576.00	1,583,040.00	12,742,313.40

However, for general information the summarized totals of the benefits, costs and economical analysis as contained in the second group of the McLennan County report is herewith presented.

What the Economical Analysis Shows.—The economical analysis reflects the actual conditions prevailing at the expiration of 40 years whether it be a benefit or a loss as is illustrated in the grouping above in the case of Highway No. 7 running east out of Waco. The analysis shows in this instance that if this road were improved as routed in this grouping on the basis of present day traffic the result would be a loss and the investment therefore not justified.

This method of determining the advisability of making a further investment is received favorably by men without technical training; the reason being that the economy of the investment is proved or displayed beyond any question and there is left no argument on either side.

Bill to Authorize Road Construction by Private Parties in Cuba.—A bill that would authorize any person or company to build any road petitioned for by the land owners of any part of the country, provided the Government approves the plans, has been introduced in the Cuban Congress. The land owners would apply to the President of the Republic for permission to construct the road, pledging their lands as guarantee for the payment of the tax levied to cover the cost of building the road. The Government would be responsible for the payment to the road builder and in turn would collect from the land owner.

Methods of Testing a Scientific Theory

By HALBERT P. GILLETTE

PERHAPS the easiest sort of inventing is to invent an explanation of an event or a class of events. At any rate almost everyone does it. So it is not surprising to find an enormous amount of literature in which this type of invention is predominant. Usually it is called scientific literature, although its claim to that distinction commonly rests only on the fact that the problems discussed are scientific problems. Perhaps it is the very abundance of this sort of writing that has brought the word theory into a sort of popular disrepute. To be called a "theorizer" is usually bad, and to be regarded as "a mere theorizer" is, in the popular eye, scarcely better than to be classed with the half-wits.

In his Logic, John Stuart Mill insists that the word "theory" should be used to designate an established scientific explanation of a phenomenon, and that the word "hypothesis" should be used to designate unestablished or tentative explanations. It would be well were this distinction observed. If it were observed, about 99 per cent of the literature relating to new explanations of phenomena would be called hypothetical. Rarely indeed is a new hypothesis supported by enough facts to justify its being heralded as a theory.

Darwin spent 20 years gathering supporting data before publishing his theory of evolution. His "Origin of Species" is little else than a marshalling of facts that indicate the existence of evolution, coupled with inferences from those facts pointing toward "natural selection" as the cause of evolution. The facts were so numerous and so well presented that relatively few impartial readers have failed to be convinced that organic evolution has occurred, and that "natural selection" has played an important part in its occurrence. By contrasting that book with most books that expound a new hypothesis, one sees very clearly the strength of Darwin and the weakness of the great majority of would-be Darwins, including Darwin's son, Sir George. The latter's book on the hypothesis that the moon was separated from the earth by tidal action contains almost none of his father's method of proof. The younger Darwin invented an hypothesis, boldly assumed several premises, as a basis for a mathematical deduction, and naturally came out with the desired answer. But not once did he produce any striking evidence that lends credence to his explanation. Finally, he admitted that his tidal hypothesis probably applies to the genesis of no other planetary body than the moon, thus raising the gravest doubts as to its truth.

If there is one thing that "Nature abhors" it is extreme uniqueness. Her practice is to vary her patterns only slightly. She even designs solar systems on the model of her atoms. So when we are told by the younger Darwin and by the elder Chamberlin that their "theories" are probably applicable in a very limited manner we have strong a priori grounds for believing that they are not applicable at all.

The enormous quantity of scientific literature like that just mentioned indicates great need of better training in research methods. Of course hypotheses must be framed before theories can be established; but it should be insisted that every hypothesis should be rigorously tested by its originator before publishing it in great detail. Brief preliminary announcements are not objectionable. The most important of the tests to which an hypothesis should be submitted is what may be termed the test of verified inferences. To illustrate, suppose the hypothesis relates to the genesis of planetary bodies, and assigns their origin to the sun, and that electromagnetic waves from sunspots are assumed to have propelled solar material into space. This hypothesis is quite as plausible as Chamberlin's or Darwin's, and it invokes no special act of creation; but if put to no test it would remain merely a scientific guess. Consideration of this sunspot hypothesis leads to several inferences, as, for example, that a series of planets should have orbital periods that are mathematically related to one another. Such a relation crudely discloses itself in Bode's law of planetary distances, and a more accurate relationship is found to exist. It discloses itself, with great precision, in the case of the first four moons of Saturn, the period of the 3rd being almost exactly double that of the 1st; the period of the 4th being almost exactly double that of the 2d; and the period of the 2d being very nearly 1.5 times that of the 1st. Similarly other period series disclose themselves among the satellites of other planets.

A second inference from the sunspot hypothesis is that some of the material ejected from the sun is halted in its flight by counter radiant pressures of other suns. If material thus ejected from a group of "sunspots" in the incandescent earth were halted by our sun, it is inferable that it might build up a moon whose diameter would just blot out the sun during a full eclipse; for the group of moon-generating "sunspots" on the earth would form the apex of a cone whose base is the sun, and the sides of this cone would mark the limits within which the sun's rays would halt the material thus ejected. As a matter of fact, the moon's diameter is only 3 per cent greater than this inference calls for, and this excess is explained by the established fact that the moon is very slowly receding from the earth. Indeed if the present rate of recession has always existed the age of the moon is calculable. When thus calculated its age is of the right order.

Applying the same hypothesis to the first six moons of Saturn, we find that the ratio of their distances from Saturn to their diameters varies but slightly from 290, and that the variation is within the observational error. But such a ratio indicates either that the sun was larger than it now is, or else that it was assisted in stopping the material (ejected by Saturn) by a planet intermediate between the sun and Mercury. This last idea offers an explanation of why the planets have such large diameters. Calculation discloses that the double star Alpha Geminorum (Castor) (the brightest of the stars) probably halted the material that formed Mercury, the earth and Saturn. At any rate, their equatorial diameters are almost exactly proportional to their distances from the sun, and that ratio is very nearly the ratio of the diameter of the orbit of the outer star of the Alpha Geminorum pair and its distance to the sun.

In this manner the sunspot hypothesis of the genesis of planetary bodies leads to a series of inferences, which result in searching for facts that either confirm or refute each inference. Soon the number of confirmatory facts is found to be so great and so closely in agreement with the inferences drawn from the hypothesis that, by applying the law of probabilities, it can be proved that the chance is thousands to one in favor of the hypothesis.

While not all hypotheses lend themselves to quantitative tests, like those just indicated, still some measure of quantification is usually possible, even if it consists only in the number of inferences from the hypotheses that are in agreement with facts. When this form of test is applied, care must be exercised not to introduce many additional hypotheses; for if permitted to introduce new hypotheses at will, almost anything can be "proved." A rigorous test consists in introducing no new hypotheses whatsoever except the hypothesis that is being tested. Of course it is permissible to assume any well established theory, but every additional hypothesis that is assumed detracts from the probability of the truth of the hypothesis under investigation, and it reduces that probability in far greater ratio than the number of hypotheses introduced to bolster up the one under investigation. This latter

fact seems rarely to be considered by the proponents of new hypotheses. Their articles and books usually start with a rather simple hypothesis, and they tell us that by means of it they will explain a great variety of phenomena. But as you read along, you will usually observe that many a new "if" and many a "let us assume" are inserted to enable the original hypothesis to explain the various facts. Count every such new assumption and you will often be amazed at the number of them.

On the other hand, when a new hypothesis needs no such crutches, but walks unaided and leads you to fact after fact, many of which have been hitherto unsuspected, there is always high probability that it is fundamentally sound.

Should the hypothesis occasionally fail to agree with some fact, it should not be rejected as improbable, for probabilities depend upon the preponderance of agreement. Where all agreements are mathematically perfect, the probability rises to a certainty, but long before certainty is attained it may be obvious that an hypothesis is fundamentally correct.

Unsuspected forces may exist, acting so as to cast discredit upon any hypothesis that fails to consider them. Further study may disclose the nature and magnitude of such forces, whereupon it often happens that when allowance is made for their effect, complete accord between the hypothesis and the facts is secured. The theory of heat transfer, for example, was unable to account for certain facts until it was discovered that the films of quiescent fluid adhering to every solid themselves act like a solid in conducting heat. Had the heat-gradient theory of conduction been rejected because it apparently failed to agree with certain facts, probably science would still be without a heat conduction formula that closely fits a vast range of conditions.

This leads to a warning and a protest. Be not too skeptical of a new hypothesis because many able men reject it. There is still a strong inclination among scientists to require perfection of every new hypothesis. They demand that the baby shall be possessed of adult strength. My protest is against such a specification. Political history may usually be "the bunk," as Ford has said, but the history of science is wonderfully informing. One important principle is there to be found again and again, and it is this: Theories never spring full grown from the head of any Jove.

Trans-Isthmian Highway, Panama.—Surveys of the proposed route of the Trans-Isthmian Highway, from Portobelo to Colon and from Colon via Monte Lirio to connect with the Madden Road between Gamboa and Alhajuela have been completed but, with the exception of the Madden Road, construction work has not been started.

Road Material Surveys in Wisconsin

In order that the road material resources of the state may be utilized to best advantage the Wisconsin highway commission requires a geological survey for each highway project to determine what materials developed or undeveloped, are available. This work has been in progress since the summer of 1920. How these surveys are made was described by E. F. Bean, state geologist in the June issue of Badger Highways.

Geology students from the University of Wisconsin are employed for this work. The employment of students is of advantage to the state since this arrangement makes it possible to secure men with training. The students profit by having practical field work each summer as they continue their university work. In 1928 the average field experience of six chiefs of party was four summers. The long field experience coupled with intensive university training results in exceptionally well qualified men.

The geological party consists of a geologist with one or two assistants. A Ford roadster with pickup body is used for transportation. The equipment consists of long-handled shovels, pick, bar, pails, screens and colorimetric silk outfit.

A careful geological survey is made of the country near the project. Knowing the rock and gravel formations, the geologist is able to eliminate large areas from consideration and to concentrate upon the more favorable ones. He knows what surface indications favor finding the particular material he is seeking, but all conclusions must be checked with a shovel. Test pits are dug just as in the exploration for iron or any other valuable mineral. It is no job for a man who is afraid of manual labor.

Each deposit, both developed and undeveloped, is given a location number, and a complete set of notes recorded. This involves screen analysis, silt and colorimetric tests, a yardage estimate, amount of stripping, water supply, and length and character of haul. A sketch is made showing the location of the deposit.

The results of the geologist's investigation of each project are embodied in a report containing a brief description of each deposit and recommending certain deposits for consideration. Copies of the notes and of the report are sent to the materials engineer, the division engineer, and the county highway commissioner. The report and notes are supplemented by a mounted folded county map upon which is shown the area covered by each report and the location of each deposit covered in the report. These maps are brought up to date at least once a year.

In 1928, 100.72 miles of concrete paving was built from local pits at an estimated saving to the state and counties of $230,990. Thus university students applying the knowledge gained in class room are enabled to save the state of Wisconsin each year a large sum of money and at the same time gain for themselves practical field experience.

How to Treat Balloon Tires

In view of the great importance to vehicle owners of proper use of balloon tires, the Standards Division of the Society of Automotive Engineers has felt that the incorporation in the S.A.E. specifications of some information on load and inflation pressures for balloon tires for passenger cars and commercial vehicles and for high-pressure tires for commercial vehicles was advisable. As the Tire and Rim Association has approved such tables for publication in its handbook on specifications, the S.A.E. tire and rim division decided to recommend that the following table be adopted as a new S.A.E. recommended practice:

Passenger-Car Balloon-Tire Load and Inflation Table

Tire Size	Wheel Diam.	Minimum Inflation Pressure, Lb. 28	30	32	34	36
		Maximum Load Per Tire in Lb.				
4.40	18 and 19	610	660	710	760	810
	20 and 21	650	700	750	800	850
4.50	18 and 19	650	700	750	800	850
	20 and 21	700	750	800	850	900
4.75	18 and 19	700	750	800	850	900
	20 and 21	745	800	855	910	965
5.00	18 and 19	745	800	855	910	965
	20 and 21	815	870	925	980	1035
5.25	18 and 19	815	870	925	980	1035
	20 and 21	880	940	1000	1060	1120
5.50	18 and 19	880	940	1000	1060	1120
	20 and 21	925	1000	1075	1150	1225
6.00	18 and 19	1000	1075	1150	1225	1300
	20 and 21	1075	1155	1240	1320	1400
(6.20) 6.50	18 and 19	1075	1155	1240	1320	1400
	20 and 21	1140	1230	1320	1410	1500
(6.75) 7.00	18 and 19	1200	1300	1400	1500	1600
	20 and 21	1300	1400	1500	1600	1700

The Roman Military Road System

Their Purpose and How They Were Built

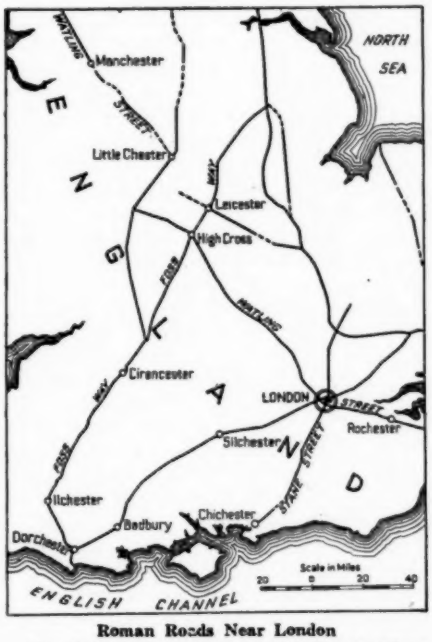
By CHARLES R. GILDART
First Lieutenant, Field Artillery, U. S. Army

AMONG the wonders of the ancient world, the pyramids of Egypt and the Colossus of Rhodes are familiar to every school child, but the grandeur of Rome's colonial road system, extending as it did like the spokes of a wheel from the mother city over Europe, Western Asia, and Northern Africa, is, in its engineering and historical aspects, little appreciated by many who profit most from its heritage.

The civilization that persisted in Europe after the fall of Rome is directly attributable to the Gallic road system which, through the ready communication it afforded, carried the lamp of knowledge to the darkest corner of the territory under the sway of the Caesars. The grandeur of conception, the engineering skill which it manifests, and the magnitude of the ancient political power which it represents, are features that excite the admiration and astonishment of the road builder of modern times.

Extension of the Road System.—Although public roads of some kind undoubtedly existed from Rome's earliest days, it was not until the fourth century after the city's foundation that any paved ways of importance to the extension and military security of the Roman Empire were built. It was in this century (or in the third century B. C., of our system of reckoning), that the great Appian Way was begun, a road not only the best of its time, but the first great highway destined to link the Eternal City with her most outlying colonies. Before the termination of the Republic there were five great roads leading from Italy into the provinces of Spain, Gaul, Epirus, and Macedonia, and finally the great Augustus and his equally progressive successors extended them to the imperial frontiers in Europe, Asia Minor, Armenia, Syria, Africa and on to the very Pillars of Hercules.

Strategical Characteristics of the Roads.—The Roman road was essentially a military way, built primarily for the rapid and uninterrupted progress of the legions on their way to and from the conquests that were the essence of the Roman power. Cardinal principles in the Roman school of highway engineering were an almost undeviating adherence to the straight line in location, and an insistence upon superior construction materials. There were no signs "Curve—Slow Down" on Roman roads; these highways ran usually in straight lines from one city to another with great disregard of the



Roman Roads Near London

The full lines indicate the known locations of the roads; the broken, the supposed routes. Many modern British roads still follow the location of the ancient Roman roads shown on the map, but, were a map of the complete present road system of this district superimposed upon the above map, the winding courses of the modern roads would stand out in strange contrast with those traced above.

natural obstacles that were incidents of such location. The Roman military engineer believed that the greater expense of construction was more than offset by the greater speed and freedom from ambush that it gave the legions, and he added to their military security by raising the road level to such a height as to command a view in all directions—literally highways. The materials were quarried from the country traversed, but when suitable materials were not at hand, they were brought to the project with great labor and expense and often from a considerable distance.

Method of Construction.—The late Thomas Codrington of England, has given to the engineering world an excellent treatise on the construction methods of the ancient Roman military engineers. From his exhaustive work on this subject, it appears that the embankment or ridge construction was a usual feature of the Roman roads of Britain. These were constructed with such care and of such well-selected materials that the erosion of centuries has left them untouched in those spots where they have escaped quarrying and scarification by the hand of man. These embankments varied in height and width as the nature of the terrain and amount of traffic dictated. The 18-ft. width, so common on present highways, was usual then, and the embankment was frequently built up to a height of 6 ft. and sometimes to 8 ft. The sides of the road were, as a rule, ditched and excavated, the dirt and stone, when suitable, providing construction material for the ridge. In other cases they were thrown outward from the road. These ditches have almost universally been filled with dirt and other debris by the action of traffic and the elements, so that excavation must be resorted to in order to determine their trace. Often the sides and bottom of the ditch were paved with stone.

Gravel, sometimes bound with lime or coarse mortar, has been found to have been a common constituent of the embankment. The Stane-street in Sussex consisted (and, in stretches, still consists) of alternate layers of flints and other stones bedded in sand and fine gravel. A portion of the Watling-street has been found to consist of a thick layer of cobbles resting on a clayey surface, surmounted by a layer of gravel a yard in depth. On marshy land, the embankment was usual, but in some cases roads in this sort of terrain were constructed on piles. The surface of the Roman road was usually paved. Early writers, who had the advantage of seeing the roads in a more perfect condition, tell of a type of paving found in the limestone districts of this country, namely, wide flat stones laid edgewise, so closely bound together that the appearance of the surface was that of a wall fallen to a horizontal position. In other cases the roads were paved with stones laid flat, or with cobblestones.

Influence on English Place-names.—Our English word "street" is the direct descendant of the Latin via strata, or stratified way. Stretton, Stratton (Street-town), Stratford (Street-ford) and similar names point to communities that grew up along the military ways, while the other place-names, not especially of Latin derivation, refer to the characteristic elevation of the roads, such as Ridge, Ridgeway, Roman Ridge, High Dyke, Devil's Causeway, et cetera.

Besides contributing to the celerity of movement of the legions, these public roads provided the means of communication between the seat of government and the outermost provinces. Posts were established at short distances, the function of which was similar to that

of the western stations along the route of the pony express of pioneer American days. These posts, called mutationes, or change houses, were placed at moderate distances from each other and each was equipped with forty horses or mules. At about 20-mile intervals (a day's journey), mansiones, or stations where travelers could spend the night, were established. These were at first simply military encampments—castra in Latin—but were later stabilized and furnished with barracks for soldiers, store souses for forage and provisions, and quarters for travelers of all ranks.

A glance at an English map impresses one with the frequence of such suffixes as "chester," "caster," and "xeter" in the names of British cities; Lancaster, Manchester, and Exeter are illustrations of these place-names. These suffixes are corruptions of the Latin castra above defined, and the present cities that thrive under these names were originally the Roman military camps along the roads of the imperators. Again we have a counterpart of this etymological incident in the sprinkling of the prefix "Fort" in the United States, particularly in the West and Middle West, where railroads instead of Roman roads were laid through savage territory under the protection of the soldier. The ramparts of Fort Dearborn, occupied by American troops, enclosed the germ from which the present city of Chicago has grown. In some instances the term "Fort" has been retained, and in others, as in the case of Chicago, it has been dropped and exists only as a memory. This is of course the case with the Roman stations; there are many "casters" and "chesters" in England, but there are also many cities not so named that owe their founding to the enforced peace of the military camp, preserved by the redoubtable legionary.

Type of Labor Used.—It is believed that four classes of people were employed in the construction and maintenance of these highways: the natives of the province, the legionary soldiers, professional artisans and engineers and criminals whose labor was exacted as punishment. Of these classes the greatest amount of work appears to have been performed by the legionaries when peace time took them from the battle-field.

Through erosion and economic revolution the traces of many of these highways have disappeared, but in Europe, remains of them may still be seen, often pointing a course as straight as the arrow, from one strategic or commercial point to another. The location of the highway system can now be traced with considerable accuracy throughout the whole of the old Roman empire. In England there are frequent instances of modern roads following the trace of the Roman roads, while excavations in other places have brought to light the materials of construction, the abutments of bridges, built with considerable skill, and even the mile-posts which, in those times were carved with the names of public benefactors, instead of with the names of soft drinks and cigarettes as in these later days.

Four Roads of Britain.—Archaeologists generally believe that there were four great streets running across Britain. Since Saxon times these four highways have been designated the Watling-street, the Erming-street, the Fosse-way and the Ickening-street. The Dark Ages so obscured the records of Roman civilization that savants are not in complete agreement as to the full itinerary of these ways, but the courses of legs of these roads and of lesser streets are certainly revealed by the excavation of indisputable remains.

The Straight-line Principle.—How rigidly did the Roman engineer adhere to the principle of straight lines in building his roads? Though straight lines are common enough in Roman military ways to be a recognizable characteristic, there was, however, intelligence in their directness. The curve was tabooed chiefly because of its lack of military security from ambush, but we find in the Stane-street, leading from the southern coast of England to London, an example of deviation by means of three legs which were themselves straight for many miles, with the starting point and direction of each so selected that the opposite end was brought to the point most advantageous for crossing the natural obstacles that lay in its path. In this case, as Hilaire Belloc has pointed out, a wild rocky country, absolutely devoid of water, called the Weald, lay between Chichester on the coast and London. Water, of course, is an essential to any military column—therefore straight-line detours were made around the Weald in such a matter that water was obtainable and the trace was not materially lengthened. It is worthy of note that, though considerable distance separated Chichester from London, and the path of the road lay through forested country, the Stane-street represents the shortest path that could be traveled when the Weald is left out of the journey.

How then were the Roman military engineers able to throw straight lines across heavily timbered country without the aid of the optical, angle-measuring devices of the modern highway engineer? This question has been answered in various ways by antiquarians interested in the Roman roads. The theory has been advanced that great signal towers were erected at the start and finish of a particular tangent so that the workmen were continually able to orient themselves upon its two ends, but it has been necessary to discard this theory in view of the height that such towers would have had to reach in order to satisfy the conditions of visibility in the country traversed. Smoke signs may have been used at either end of the tangent on thinly timbered reaches. But not until the antiquarians got into liaison with the practical highway engineers was a logical solution reached as to how the straight lines were laid out in heavily timbered stretches of country. Technical readers of this magazine may have, in making a traverse over thickly forested country, used the method of "odds and evens." This constitutes the later theory of Belloc in accounting for the Romans' ability to draw straight lines across country without error, and strike a target 20, 30, or 40 English miles away. According to this procedure, a gang of men is strung out across the territory between the opposite ends of the projected road. They are numbered consecutively from the starting point to the finish. All odd-numbered men face toward the finishing point of the project, and all even-numbered men face toward the starting point. They are so distributed that each man can see the next two men in front of him. Working from both ends of the projected road they line each other up, first on the starting and finishing points, and then as they work toward the interior, upon each other. The first distribution of the men will not of course result in a straight line, but when the lining up process has been completed, the result will be a clean-cut, straight line from point to point. Markers are then driven in the ground where each man has been finally lined in and the path of the project has been laid out.

It is generally true that the angles between tangents, when the change of direction is not at a road-station, occur at a well-defined point on high ground. Codrington states that he has noticed several turning points where barrows or tumuli were the landmarks used in sighting. Where a slight deviation would avoid the crossing of a stream bed, or the ascent of a steep hill, this change was usually made, and the straight line was often resumed on the other side of the obstacle. In crossing valleys having steep sides, the road is often seen to wind down and up, and a winding course is taken in extremely broken country, but the military considerations, that were in the minds and entered into the plans of the Roman engineers, are evident from the resolute facing and surmounting of obstacles that could have been avoided, had the situation been entirely civil with no tactical considerations involved.

Acknowledgment.—The foregoing is taken from the May-June issue of The Military Engineer.

Road Construction in the State of Victoria, Australia.—Since the creation of the Victorian Country Roads Board in 1912 the Board has spent $80,474,-445 on the construction and maintenance of roads within the state, and now has under its control 11,509 miles of state highways and main roads.

Highway Development and Its Problems in Indiana

Location—Mileage—Accidents—Traffic Increase and Maintenance

By A. H. HINKLE

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THE development of a system of improved state highways in Indiana suitable for modern traffic has made slow but steady growth starting about 10 years ago. Although making rather slow progress at first, it has increased in speed and quality of roads each year.

Few states have done better in the selection of its through routes so as to best accommodate the heavy through traffic which is rapidly developing.

Proper Location of State Roads.—The highway commission has frequently put up a fight against much opposition in order to properly locate a road to accommodate the through traffic. It is an easy matter for the commission to yield to private influences in routing a through road so as to satisfy individuals and perhaps insert a mile additional length in the road. Few of us have realized the loss to the traveling public in future years by the additional lengths that might be placed in our state highway system.

One needs but to multiply the daily vehicular traffic by the number of days in the year by the added length in miles by the cost per vehicle mile, to discover that an enormous burden may be placed upon the public by poor locations. We have been told this frequently yet need ever to keep it in mind that we may use good judgment in the proper locating of our heavily traveled roads. Too frequently we confuse the theory of a system of through roads with purely local roads.

The importance of the proper location of a system of through roads may be brought to us by a simple problem. Let us assume that our state highway system has, or can be, shortened by 1 per cent by proper location. With 5,000 miles of road in the state system and assuming the cost of transportation to average 10 ct. per vehicle mile, an average daily traffic of only 600 vehicles, the annual saving to the traveling public by this shortening would be 5,000 (miles) × 1 per cent × 600 (vehicles per day) × 365 (days) × 10 ct. = $1,095,000. One little realizes the magnitude of this important problem until he analyzes it in this manner. These figures do not include the saving in road maintenance on the shorter route.

Generally speaking, roads should be so located that they will shorten the distance of the greatest number of vehicles. However, we should not make the mistake of attempting always to make the through road and local road one and the same thing. For instance, by routing it through a congested district over a longer route, two handicaps are introduced to the through traffic and the added local congestion may greatly interfere with the local traffic.

Generally it is not good practice to combine two important roads as they approach a large city, particularly if this combination adds length to either road. Such an arrangement may not only add to the already congested condition at such places but also by the added length make both routes less satisfactory. In such cases not only the through traffic but also the local traffic may not be so well accommodated.

The principal difference between a large city and an entire state such as Indiana, is that in the former we can quickly and readily go from place to place, while in the latter, the distances are greater. By shortening the distances in the latter, it is possible to approach the conveniences obtained in the large city. With the most direct routes, wide and suitable pavements free from congested districts, the whole state gradually will approach one large city for conveniences. It is needless to enumerate the advantages of such a condition prevailing in this state. Hence, the desirability of giving great study when any important through highway is diverted from its most direct location between populous centers.

Frequently arguments are made for the location of a state road to accommodate the local traffic at the expense of the through traffic because the former is the greater. Regardless of the location of any state road, the local traffic need not be accommodated less, for local roads should be so built and connected with the state highway system that the local traffic will in no wise be discommoded by the location of a through route but on the other hand, it may be aided and helped by freeing districts already congested with local traffic from the ever increasing through traffic.

Advantages of Locating Through Roads Over Shortest Practical Route.—Mention may be made of the great advantage of the direct line from Indianapolis to Lafayette; yet our highway commission perhaps received more criticism for building this direct line instead of diverting it in a circuitous line 5 miles longer, than for any other one piece of work that has been performed during the history of the commission.

This direct line from Indianapolis to Lafayette is not only of advantage to the heavy traffic but it is also a direct financial asset to the Purdue athletic field in that more attendance results

Table I.—Annual Average Maintenance (Only) Expenditures per Mile on the Various Types of Roads

TYPES OF SURFACE	Year 1924		Year 1925		Year 1926		Year 1927		Year 1928		Average Yearly Expenditures for the Five Years
	Mi. on which Expenditures based	Average Expend- iture per Mile	Mi. on which Expenditures based	Average Expend- iture per Mile	Mi. on which Expenditures based	Average Expend- iture per Mile	Mi. on which Expenditures based	Average Expend- iture per Mile	Mi. on which Expenditures based	Average Expend- iture per Mile	
Brick	53	$ 184	47	$ 240	50	$ 254	41	$ 336	61	$ 295	$ 260
Cement Concrete	385	163	597	150	815	207	868	227	1148	217	201
Bituminous Concrete	15	570	14	187	16	679	14	444	23	313	428
Rock Asphalt									12	232	232
Bituminous Macadam	24	606	49	554	123	596	102	350	150	454	489
Surface Treated Waterbound Macadam, Gravel, Stone and Bituminous Retread	7	317	7	865	21	533	71	727	131	728	704
Stone	634	657	601	662	776	819	637	869	711	911	786
Gravel	1539	711	1351	591	1131	627	901	639	1073	747	664
Miscellaneous							1703	479	1264	465	473
ALL TYPES	2655	605	2666	500	2933	553	4437	519	4972	541	541

therefrom to every football game. It does not take a financier to compute the financial gain to the athletics of our state university if the university were located at the outskirts of Indianapolis where a large population can readily reach the athletic field on important events. However, if we can make the road so direct, wide and accommodating, that little inconvenience is encountered by the traffic from Indianapolis, the same advantages are approached as if the university were moved toward this populous center.

By the locating of this road on a direct line, no additional handicap was placed upon the people of Frankfort. Four state roads lead to this town and perhaps even more will reach it in future years. The citzens of Frankfort are not required to travel any additional distance by building this direct route from Indianapolis to Lafayette. The only advantage that could have come to this town in diverting this road out of its path to pass through the town would have been the small purchases made from the merchants. The additional distance by way of Frankfort for through traffic is about 5 miles. For 1,000 vehicles per day this additional distance would have cost the through traffic annually about

1,000 (vehicles) × 365 (days) × 5 (miles) × 10 ct. = $182,500.

You can look back now and see how ridiculous it would have been to have imposed the enormous burden of the five additional miles on the through traffic in order to bring to the merchants of this town the little advantage they would secure. I cite this road as a concrete example of the advantages and saving to the public in locating a through road over the shortest practical route.

The Proposed Transcontinental Highway.—You perhaps noticed an article in the newspapers a few days ago about a system of through highways proposed by Congressman Hall, which system as proposed, is to consist of about 7 transcontinental routes east and west; 15 or 20 routes north and south across the United States with certain diagonal routes. There is little need of any such system or super-highways if we use good judgment in laying out and developing our present federal system. However, if we yield too much to individual demands in locating the present highway system by diverting important federal routes out of their way to accommodate purely local interests, we are certain to force upon us some such system of super-highways as Congressman Hall proposes. It is believed that the local traffic can be taken care of far better and the through traffic accommodated just as well by the proper laying out and development of our present approved federal highway system. Congressman Hall's proposed system is as extreme in one direction as the yielding to individual selfish interests so as to divert our present federal system away from direct lines, would be in the other.

I am making this argument in order to appeal to you to cooperate with your highway commission in making short cuts wherever at all possible that you may do something for the future development of your state that will be an asset to it far beyond any minor local advantage in diverting through traffic out of its way for some small local accommodation. Also the following of direct lines will make unnecessary any such special super highway system (and the unnecessary expenditure of billions) as proposed by Congressman Hall.

Miles of Road in the State System and Rate of Improvements.—On Jan. 1, 1929, there were in the state highway system, 4,610 miles of road grouped according to surface as follows:

Miles	Dustless Type
0.89	Wood block
81.29	Brick
1,597.29	Cement concrete
100.37	Rock asphalt
81.53	Bituminous concrete
257.53	Bituminous macadam
29.19	Surface treated W. B. mac.
137.15	Bituminous retread top
2,285.24	Dustless type

Miles	Non-Dustless Type
871.06	Stone road
1,322.00	Gravel road
17.88	Earth road
105.95	Road torn up for construction
7.72	Miscellaneous
2,324.61	Non-dustless type

One of the big problems of your state highway commission is to transform the types in the right hand column of the above tables into the types of the left column.

There are 354.62 miles of state routes inside of cities of over 2,500 population, which if added to the state roads being maintained outside of cities makes a total of 4,964.57 miles of state routes. "State roads" refer to roads on the state highway system maintained by the state exclusive of detours, while "State routes" include the state roads together with those streets inside of towns of more than 2,500 population which are marked with the state road numbers but are not maintained by the state.

The mileage of different types of surface maintained by the state on Jan. 1, 1929, might be regrouped according to surface in the following classes:

(1)	2,073.45 miles	Pavement
(2)	216.34 "	Surface treated stone and gravel
(3)	2,193.06 "	Stone and gravel roads
(4)	17.88 "	Earth roads
(5)	109.02 "	Road torn up for construction
	4,609.85 "	Total

During the past fiscal year ending Sept. 30, 1928, the state built pavements or some form of dustless top as follows:

230 miles	Cement concrete
64 "	Rock asphalt
26 "	Bituminous macadam
37 "	Bituminous retread or surface treated macadam
357 "	Total

Assuming this present rate of improvement which is the largest in the history of the commission, it would be 7 years before the present state highway system would be paved or improved with some form of dustless top.

It is true that the present rate of revenues, because of increased registration of motor vehicles and gasoline consumption will likely increase each year; however, due to demands on the funds for widening the roads and a very extensive bridge program, it is doubtful whether this rate of converting our gravel and stone roads into some form of pavement can be increased with the present rate of revenue. This does not take into account the additions to the state system which are being made from year to year and which are very neces-

Table II.—Distribution of Maintenance Expenditures for Fiscal Year Ending Sept. 30, 1928

Type of Surface	Miles on which Expenditures is based	Expended on Surface	Roadbed	Structures	Snow Removed	TOTAL
Brick	61.18	215.20	68.90	3.00	7.60	294.70
Cement Concrete	1,148.18	72.40	128.40	5.50	10.40	216.70
Bituminous Concrete	22.72	201.50	86.70	19.30	5.40	312.90
Rock Asphalt	11.95	89.80	121.50	20.00	.20	231.50
Bituminous Macadam	149.83	336.10	103.20	6.30	8.60	454.20
Surface Treated Water Bound Macadam, Stone and Gravel, and Bituminous Retread	131.41	653.50	63.20	6.20	5.00	727.90
Stone	710.60	838.10	55.90	14.10	3.00	911.10
Gravel	1,072.90	677.40	49.50	16.70	3.80	747.40
Miscellaneous	1,263.59	385.30	61.90	13.80	3.80	464.80
ALL TYPES	4,572.36	447.90	76.60	11.80	5.65	541.80

sary as the traffic increases and our state develops.

Accidents on the State Highways.—We attempt to make a report of accidents happening on the state highway system each year with a view of securing the data so far as possible that might contribute to the cause of accidents. This information should aid us in reducing the accidents.

Because of the great number of minor accidents it is necessary to limit these reports to those in which a person is injured or killed or wherein property damage is $25 or more. During the past year 668 accidents, resulting in 191 fatalities, were reported. These reports are made on a new form recently adopted by the American Association of State Highway Officials, which is a modification of the card form originally prescribed by the National Safety Council.

That accidents and fatalities are increasing at an alarming rate is quite evident from these reports. The reports furnish a valuable study preparatory to bringing about means for the prevention of accidents.

The summary of accident reports show that many things, such as narrow roadbeds, deep ditches, narrow culverts, close proximity of poles and trees, railroad grade crossings, glaring headlights, headlights too dim, obstructed view at road intersections, intoxication and numerous other things all lend contributing causes to these accidents.

To close the comments on this subject, a slide will be shown on which is a curve of fatalities occurring on the state highway system during the past 8 years. This shows that the curve of fatalities is rising at a sharper angle each year, even though the motor vehicle registration curve is flattening. The fatality curve is keeping about parallel with the gasoline consumption curve which latter curve is a pretty accurate indication of the traffic. The regularity of this fatality curve would indicate that there are constant forces contributing to accidents on our highways. It seems unbelievable that we could predict a year ahead of time very largely the number of fatalities that are going to occur on our state highway system, yet the records of the past, as indicated by the curve, will show that unless we resort to some radical means of reducing accidents, this prediction can be quite accurately made. One might well predict that motor vehicle accidents on the state highway system will cause about 240 fatalities this fiscal year.

The safety work of the highway commission is just as necessary as the building of good roads, and it is one of the many problems which must be given attention and study.

Marking and Signs on the State Highways.—Perhaps no one thing has brought any more commendation of our state highway system than the standard system of markers and signs which are now used thereon. While this work is costing about $50,000 per year, or about $12 per mile, no one would advocate a reduction in our activities along this line. In fact, we are requested almost every day to do more centerline marking and erect more guide signs at strategic places.

Increase in Traffic.—The traffic on the state highways is constantly increasing. Without an accurate traffic count the trend of this traffic increase can be judged from: (1) the increase in motor vehicle registration; (2) gasoline consumption. The increase in motor vehicle registration is dropping, this past year being only 3.2 per cent. However, the increase of gasoline consumption is getting larger and the gasoline consumption is an accurate measure of the use of highways by motor vehicles; hence, we can conclude that the traffic on our highways is increasing at a rapid rate in spite of the tendency of the increase in motor vehicle registration to reduce.

Increase Over the Preceding Year

Motor Vehicle Registration				Gasoline Consumption	
	Per Cent		Per Cent		Per Cent
1919	21.1	1924	11.5		
1920	17.0	1925	11.3	1925	15.9
1921	22.4	1926	6.8	1926	7.9
1922	16.9	1927	5.4	1927	12.9
1923	23.3	1928	3.2	1928	14.1

Busses have increased this past year 13 per cent over the preceding year, which is indicative of the expansion of this public utility. It is useless to say that with this constant increase of traffic on our state highways the highway commission will soon be confronted with the problem of widening the pavements as well as many of the bridges to accommodate same.

Condition of State Highways.—With the increased pavement each year the condition of our state highways for traffic is gradually growing better. It is particularly noticeable that our gravel and stone roads are far superior for winter traffic than they were a few years ago. You can well remember when but a few years back these types of roads were usually considered unsuitable for winter traffic. They cut up and usually froze rough and in the spring of the year were generally impassable for weeks and sometimes for months. However, with our better and more systematic system of maintenance, these types of roads now, as a whole, are perhaps generally better for automobile traffic during the winter season than during the summer season because of the dust nuisance during the latter period. This is greatly magnified not only by the increased traffic but also by the balloon tires and higher speed traffic.

While it is necessary to restrict truck traffic on these types of roads during the spring thaws, it is unusual that they become impassable to ordinary automobile traffic; our laws permit the seasonal restrictions of heavy traffic on the stone and gravel types of roads. Through this instrument these roads are protected at critical times; however, it is believed that there should also be some provision in the law wherein the heavy loads could be further restricted on pavements during the seasons of the year when the foundations are soft and unstable.

Fourteen ton loads over our pavements during such times are certain to cause great destruction to them and require costly repairs. Also, provision should be made for limiting the loads on weak bridges. Some states have provided for this restriction. Indiana should have such a restriction, not only to protect the weaker pavements but also to protect the weak bridges. It is doubtful under our present laws if we can limit the load below 14 tons that will go over a weak bridge.

Cutting Into State Roads.—Owing to the development and progress being made in our state which is largely induced by the good roads we are building, public improvements, such as drainage, power lines, telephone lines, etc., are being constructed at a rapid rate. It is necessary to protect our improved roads against undue destruction by these other public improvements.

The highway commission has adopted a schedule of chargees for cutting into state roads, and it is believed that such charges are more than justified. It is attempted to make these charges on a scale proportionate to the damage done the road and I solicit your help and cooperation in protecting the costly highways we are building by some such means.

It is hardly fair to spend large sums of money for a costly road one day and permit another industry to destroy it the day following. The utility or project which destroys the pavement should bear the expense caused thereby. Our public utilities are just as necessarily a part of our present social and economic life as are our highways and we should not impose any unfair or unnecessary expense upon them; however, on the other hand, they should cooperate with the governmental institutions to bear their legitimate part of the expense incurred by their development. This is only another way of saying that each citizen should pay for the service he receives without imposing the burden of his luxuries and advantages upon his fellow men.

Cost of Maintaining Different Types of Surface on State Roads.—In Table I is given the cost of maintaining the different types of road surface on the state highway system during the past five years. These cost data are kept by our bookkeeping and accounting system in the central office and are valuable records for the study of highway economics.

Acknowledgment.—The foregoing paper was presented at the 15th annual Purdue Roads School.

Factors That Control the Quality of Concrete Used in Pavement Construction

Some Conclusions Based on Density and Crushing Strength of Concrete

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THE major part of the aggregates used in the construction of concrete pavements, in New Jersey, during the last ten years, have come from a comparatively few deposits and are principally of one quality and type. The crushed stone was prepared from diabase (trap-rock) or dolomite, both of which have about the same physical properties. The gravel was of the river deposit, glacial type or coastal plain. The former type of gravel is composed principally of flint, quartz, quartzite, granite and gneiss pebbles with a small percentage of shale. The coastal plain gravel is practically pure quartz. The pebbles are usually badly eaten and seamed. Practically no change in the quality of any of these materials has been noted during this period.

The requirements limiting the maximum and minimum sizes of these materials have been practically the same for the last ten years. The changes made were to help insure a uniform product rather than a change in the size or grading of the product itself.

The sands were either river bank sands, similar in composition to the river gravels, or were coastal plain sands. The latter sands are generally composed principally of grains of pure quartz and are frequently used without washing. Some of these sands contain from 2 to 4 per cent of clay uniformly distributed throughout the sand. The character of sands in these banks has changed but very little, if any, during this period. The sands produced a few years ago, when the production was comparatively small to what it is today, were in no way inferior in quality or grading to the sands that are now being produced.

The portland cement used during this period complied with the standard requirements for such a material and generally exceeded these requirements by a safe margin. This cement practically all came from the Easton District.

If the quality of the course aggregate, or quality and grading of the fine aggregate, used during this period in New Jersey, were the dominating factors that control the quality of the concrete, the pavements constructed during this period would be similar in character within reasonable limits.

Unfortunately, some of the earlier pavements constructed have not given the service desired. They soon began to show marked evidence of premature deterioration, such as surface peeling or scaling with subsequent cracking and raveling. In view of these facts, it is self-evident that the quality of the concrete used in their construction depended upon other factors more than upon the merits possessed by the aggregates themselves.

View Showing Pavement on Route 26, Through a Town

Aggregates Not Dominating Factor.—It is not recommended that the quality of the aggregates used in pavement construction should be lowered because such aggregates are not the dominating factors controlling the quality of the concrete. The use of second grade aggregates would undoubtedly lower the quality of all the different grades of concrete produced. In other words, the same factors would control the quality of the concrete, but the general quality of the concrete would be lowered, no doubt, in direct proportion to the difference that exists between the two grades of aggregates.

The behavior of some of these pavements would indicate that the concrete used in their construction was not all of one character or quality. The life of these different pavements has also varied with the quality of the concrete used. Since the pavements that have failed have not been subjected to conditions that differ greatly from those which have not shown those premature signs of failure, it is self-evident that the concrete used in these poorer grades of pavements must differ in physical properties and composition from that used in pavements which have not developed these defects.

The Problem.—The problem appears to be:

1st. To dicipher what these injurious factors are.

2nd. To establish a method whereby the relative amount of injury they may do can be detected during the construction period.

3rd. Prove by the data collected during the construction period, and the behavior of the pavement since that time, that these are the factors which control the quality of the concrete and the life and durability of a concrete pavement.

Construction Data Not Complete.—Unfortunately, the construction data are not always as complete as desired. The specifications may have required a definite composition of concrete to be used as 1:2:4 or 1:2:3. These proportions were sometimes changed when the character of the concrete did not appear proper. Such changes usually meant an increase in the sand content, for a reduction in the coarse aggregate would increase the cost to the contractor, who, naturally would not favor this kind of change. Such changes could easily reduce the strength of the concrete from that required for a surface pavement to that of a foun-

dation. Fortunately, few such changes were made without detection.

Again, no correcting factor was used, during the early part of this period, for the difference in volume between wet and dry sand. This fact would have a tendency to increase the strength of the concrete, other conditions being the same. Since both of these conditions affect the character of the concrete, which is determined by factors applied to the finished product, such changes do not necessarily mean that the conclusions based upon these factors will be erroneous.

While this paper is concerned chiefly with the factors affecting the quality of the concrete, which in turn determines as a general rule the life of a concrete pavement, there are, however, other factors that affect the life of a concrete pavement to a certain extent, but not to such a degree as the quality of the concrete used.

The stability of the sub-grade in conjunction with the drainage conditions to which it is subjected have, in certain instances, proven detrimental. However, the damage that these conditions can do a concrete pavement appears to be greatly exaggerated. Water will not injure a properly constructed concrete pavement unless the stability of the sub-grade is ruined by it, or its presence in excess in spots in the sub-grade makes possible undue and uneven displacement. Uniform heaving or settling of the sub-grade will do very little damage to a properly constructed pavement.

Another factor, other than the quality of concrete, that will affect the life of a concrete pavement, but which has also been greatly exaggerated, is the thickness of pavement required for a given type of traffic. It appears to be assumed by many engineers that, if the pavements are made thick enough, they will give the service required even if the quality of the concrete is questionable. Such an assumption does not appear to agree with the service such pavements have given in New Jersey for the quality of the concrete appears to be the dominating factor and not the thickness of the pavement. By this the writer does not mean that a pavement, if made abnormally thin, will give satisfactory service, but he does believe that a 6-in. concrete pavement, constructed of concrete having a crushing strength per square inch of 5,000 lb. or more, will give better service than an 8-in. pavement constructed of concrete where the crushing strength is 3,000 lb. or less, other conditions being equal.

Factors Controlling Quality of Concrete.—The principal factors which appear to control the quality of concrete of a given composition, stated according to the relative amount the concrete is effected by said factors, are, in the writer's opinion, as follows:

1st. Consistency and plasticity of the concrete mixture.
2nd. Mixing time.
3rd. Grading and uniformity of the coarse aggregate.

The manner in which these three factors effect the properties of the concrete are shown by

1st. The density of the concrete.
2nd. Crushing strength.
3rd. Tensile or flexual strength.

Density is placed at the head of this list, for, apparently, the life of a pavement is limited if the concrete does not have the required density, regardless of what its initial strength may be.

Conclusions Based on Density and Crushing Strength.—The conclusions herein stated are based, principally, upon the density and crushing strength of the concrete as determined from cores taken from the finished pavement and not upon test specimens cast during construction. The former represent the actual concrete as it exists in the pavement as it has been modified, or effected by finishing or curing. This method also eliminates the personal factor which is usually present in field cast specimens. Again, errors in construction can be detected much easier by the crushing strength than by tension tests, since the former is about six times more sensitive than the latter. Reinforcement is used to correct the deficiency shown by concrete in tension. Consequently, the unreinforced test specimens do not show the tensile strength possessed by a reinforced concrete pavement. For this reason the tensile test is only considered of minor importance as an index factor.

There is little doubt that a mere statement of the factors given above, which, in the writer's opinion, generally control the life of a concrete pavement, is not sufficient to prove to those who have formed other opinions that the conclusions thus arrived at are correct.

Consequently, we will examine the records of a number of pavements where such factors as character of aggregate, composition of the concrete, sub-grade conditions, etc., were very similar, yet the concrete in these pavements differed greatly in character at the time of construction and the behavior of the pavements since that date have also shown a similar difference.

A Study of 1919 and 1920 Pavements.—The pavement of Route 1, Section 2, Monlo Park to Rahway; Route 13, Section 1, Kingston to Ten Mile Run; Route 13, Section 3, New Brunswick to Three Mile Run; were constructed in 1919 and 1920, of broken stone and unwashed bank sand containing from 1 to 4 per cent of clay, evenly distributed throughout the sand. The composition of the concrete was 1:1½:3 or 1:2:3, the thickness of those pavements was 2 in. on the edges and 10½ in. in the center. No reinforcing metal was used in these pavements or dowel bars in the joints.

Certain portions of these pavements were constructed on a new sub-grade, while the sub-grade on the remaining portions was an old macadam road. Chute mixers were used in the preparation of the concrete for some of these pavements. The quantity of mixing water used was excessive, also, the mixing time was reduced to the minimum. The consistency of the resulting concrete was what is usually termed as "sloppy"; i. e., had a slump of about 6 to 8 in.

Unfortunately, no test cores were taken from these pavements at the time of construction, yet the control cubes showed the concrete to have less than 3,000 lb. crushing strength when 28 days old. Cores were cut, however, when these pavements were over two years old and the crushing strength of the concrete at that time was found to be between 3,000 and 4,000 lb. per square inch.

These pavements began to show signs of premature failure within two years after construction. The initial defects that developed were chiefly scaling and transverse cracking, yet diagonal cracking, broken corners and disintegration started a couple of seasons later. Very extensive repairing was required on these pavements when they were from three to four years old. Some of them have now been resurfaced.

The behavior of these pavements would indicate that the concrete used in their construction did not possess the properties such a material should have when used in pavement construction. Also, that the thickness of the pavements in no way compensated for the deficiency in the quality of the concrete itself. The sub-grade conditions were not abnormal or differed to any extent from similar sub-grades used with this same type of pavement where no such defects have developed to date. Apparently, the factors in this particular case, which have caused the most damage, were the low density and strength of the concrete.

The Burlington-Roebling Pavement.—The pavements on Route 2, Section 1, Burlington to Roebling; Route 2, Section 2, Roebling to Bordentown; were constructed in 1919 and 1920, of washed river gravel and washed bank sand. The gravel was well graded and contained very little, if any, fine material. The composition of the concrete used was 1:2:3 in one section and 1:1½:3 in the other section. The pavements had a thickness of 6 in. on the edges and 8½ in. in the center. No reinforcing metal was used in these pavements or dowel bars in the joints.

Chute mixers were not used in the construction of these pavements, but excess mixing water was employed, more or less, throughout and the mixing time was frequently less than that specified. The sub-grade under both of these sections of pavement was composed of a loamy sand or road gravel. There was good vertical drainage at

most points, yet a few soft and unstable places were encountered.

No cores were taken from these pavements at the time of construction, but the control cubes showed the concrete to have an average crushing strength, at 28 days, of less than 3,000 lb. Cores that were cut from these pavements a couple of years later showed an average crushing strength of about 3,500 lb. These pavements were constructed by different contractors, yet the methods of construction employed were very similar. Both of these sections of pavement began to scale and develop diagonal cracks across the corners within a short time after construction.

The quantity of corner breaks was excessive compared with other pavements that have failed prematurely. However, where such defects have developed, the thickness of the concrete is frequently only 4 or 5 in. Neither of these sections of pavement have been resurfaced to date, yet there has been a considerable yardage of pavement replaced.

The composition of the concrete in these two sections of pavement, apparently, has had very little effect on their durability since they are both about equally bad. There is, however, in both sections slabs that have not developed any marked defects as yet.

The composition of the concrete in such slabs is the same as in those slabs where failures have occurred. No doubt, the contractor inadvertently happened to prepare this concrete so that it has the required consistency.

Here again, the thickness of the pavement appears to be only indirectly responsible for the defects that have developed. Had dowels been used in the joints and the pavements had the thickness specified, it is evident that the quantity of broken corners would have been greatly reduced.

Another pavement recently constructed had a uniform thickness of 8 in., two lines of reinforcement and dowel bars in the transverse joints, has also shown defects in proportion to the strength of the concrete. The concrete in this pavement was prepared from gravel, washed bank sand and considerable excess mixing water. Cores were taken during construction; each core representing 1,000 sq. yd. of pavement. The majority of these cores were broken when 28 days old and had an average strength of 3,734 lb.

The average crushing strength, however, on cores in certain sections of this pavement, which were over 28 days old when broken, was about 3,000 lb. When two years old, this pavement had 36 broken corners and 60 transverse cracks. Of the 36 broken corners, only three were on the outside edges. Other pavements constructed at the same time, of practically the same aggregates, composition and thickness, but with a more uniform and higher strength of concrete, have developed very few, if any of these defects.

Effect of Sand.—The fact should not be overlooked that the sand used in the preparation of the pavements on Route 1 and Route 13 was unwashed and contained a considerable quantity of clay, while that used in the construction of both sections of pavement on Route 2 was washed and practically free from clay, yet all these pavements developed similar defects.

It has frequently been claimed that the clay contained in a sand is more or less responsible for the scaling. The value of such claims is very doubtful, but they do afford a plausible alibi, in many cases, for a bad construction condition.

Route 26 (Rev.) Section 1, Trenton - D. & R. Canal Station 0+00 to Station 180+00
Contractor - A. Stryker, Inc.

Concrete, Surface - Pavement 9" thick - Reinforcement, 3/8" Deformed Bar-Proportion 1-1.55-3.5
Cement, Vulcanite-Dragon, - Fine Aggregate, Washed Bank Sand - Coarse Aggregate, Washed Gravel

Station	Direction	Side	Core No.	Date Laid	Date Cut	Depth	Comp. Strength No.Sq.In.	Age Days	Reinforcing From top of Cores. Inches
12+00	D&R Canal	Right	A7169	8/27/28	9/18/28	9.05	5826	28	28
20+10	"	"	A7167	8/25/28	"	9.65	5522	32	4.3
28+00	"	"	A7165	8/24/28	"	9.13	6612	32	2.3
36+00	"	"	A7163	8/23/28	9/17/28	8.07	3737	34	None
44+00	"	"	A6882	7/16/28	7/28/28	8.92	4733	28	2.7
52+00	"	"	A6881	7/17/28	"	9.28	4787	28	3.4
60+00	"	"	A6880	7/16/28	"	8.96	4249	28	3.0
68+00	"	"	A6879	7/12/28	"	9.33	4967	28	3.0
76+00	"	"	A6878	7/11/28	"	9.40	4423	28	2.9
84+02	"	"	A6851	7/10/28	7/21/28	9.43	5256	28	3.3
92+00	"	"	A6850	7/9/28	"	9.00	5404	28	3.5
99+98	"	"	A6849	7/7/28	"	9.15	5449	28	3.0
100+00	"	"	A6848	"	"	9.10	Not tested		
108+00	"	"	A6847	7/5/28	"	9.12	5874	28	3.2
116+00	"	"	A6846	7/4/28	"	9.26	5398	28	2.5
124+06	"	"	A6789	6/2/28	7/10/28	9.15	6164	46	3.0
132+16	"	"	A6788	6/28/28	"	8.94	5166	28	2.9
132+18	"	"	A6787	"	"	9.00	Not tested		
140+12	"	"	A6786	6/27/28	"	9.08	5818	28	2.4
148+00	"	"	A6785	6/26/28	"	9.15	5025	28	3.6
156+00	"	"	A6784	6/25/28	"	8.90	4822	28	3.1
164+00	"	"	A6783	6/19/28	"	9.23	5155	29	2.8
168+64	"	"	A6743	6/18/28	6/30/28	9.29	5185	28	3.0
168+75	"	"	A6744	"	"	9.34	5422	28	3.5
168+86	"	"	A6745	"	"	8.83	5176	28	2.7
178+00	"	"	A7055	"	9/1/28	9.02	5800	32	None

Laboratory Record Core Drill Summary

In New Jersey, we have a considerable mileage of pavement constructed with unwashed sands that have not shown any more scaling or other defects than similar pavements constructed with other sands which were practically free from clay or loamy content, or so-called laitenance.

To assume that the peeling of a concrete pavement is caused by the fine material contained in the sand, requires a rather elastic imagination. This so-called laitenance material is generally very finely divided and will remain suspended in water a considerable length of time. If it is carried to the surface of the concrete by excess mixing water, then it must change its physical character suddenly or else the water becomes totally disgusted with it, for the excess water that comes on, or runs off the surface of a concrete pavement is invariably clear and free from all such laitenance. Again, the analyses we have made of such scale shows that it has practically the same composition as the mortar contained in the body of the pavement. The concrete in the surface of a pavement that has scaled generally has a very low density. Such concrete readily absorbs surface, or rain water and as easily loses it by evaporation. This constant wetting and drying changes the lime in the cement from a silicate to a carbonate, which not only lowers the strength of the mortar but further reduced the density of the concrete, for the lime is made soluble by such a change.

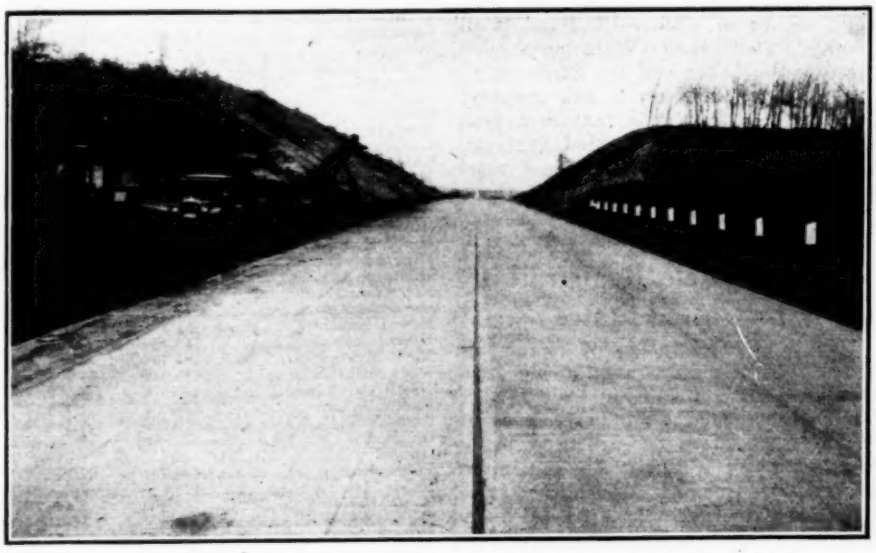
Lack of Density Causes Scaling.—The lower the density of a pavement, the more rapidly this action appears to take place. Analyses made on the scales detached from some pavements and the top of the concrete itself have shown the presence of as high as 10 per cent of CO_2. Samples taken from other pavements, which had the required density and were at least five years old, did not show the presence of but very little, if any, CO_2 in the surface layer of the concrete.

It is the writer's opinion that this lack of density in the surface of a concrete pavement is the real cause of peeling. This condition makes it possible for surface waters and frost to do the maximum amount of damage. If the fine material contained in the sand was in any way responsible for this peeling, then the addition of such admixtures as hydrate lime or celite would accelerate peeling, however, just the reverse appears to be true.

Again, concrete foundations, prepared from lean mixtures with excess mixing water, usually are deficient in density. Such concrete appears to be very prone to lose its strength in a few years and then generally shows the presence of considerable CO_2.

Large Mileage Has Developed Few Premature Defects.—Fortunately, only a very limited mileage of pavements have been constructed in New Jersey of the character of those described above. We have, however, a large mileage of pavements which were constructed with the same aggregates and cements as those enumerated, yet have developed very few premature defects. Practically all of these pavements are now over four years old. The average crushing strength, at 28 days, of the cores taken during construction from the majority

of these pavements was between 4,000 and 4,500 lbs., yet the crushing strength thus determined on some pavements have dropped to as low as 3,500 lb. These pavements, however, are not in as good condition as those which were prepared from the stronger concrete. It is not uncommon to find one or two abnormal slabs per mile in a pavement that is otherwise in first class condition. It is self-evident in such cases that something happened during construction that was not required in the specifications. Such slabs should not, but have been, included in the summaries compiled.



View of Pavement on Route 26. Trenton to New Brunswick, N. J.

The various sections on Route 4, from Lakewood south, comprising about 36 miles of pavement, does not have over three transverse cracks or one broken corner per mile. The quantity of scaling is very limited and the general condition of these different sections of pavement is very satisfactory.

The different sections of pavement on Route 7, between Freehold and Asbury Park, showed very little scaling or broken corners and not over three transverse cracks per mile. Some sections of pavement on Route 1 are also in good condition considering their age and the type of traffic to which they have been subjected.

The sections of pavement thus cited are typical of those where the construction conditions were such as to insure the production of a concrete that would have about 4,000 lb. crushing strength, or more at 28 days. When the crushing strength has dropped below 3,000 lb., usually premature defects soon began to develop. Above this limit, the defects appear to gradually decrease and are slower to appear.

Effect of Grading of Coarse Aggregate.—It has frequently been noted that when the grading of a coarse aggregate changes so as to increase its void content, the strength of the concrete is usually reduced. This is particularly true when the ratio of fine to coarse aggregate is 1 to 2. Such changes effect the workability and consistency of the concrete which the contractor endeavors to remedy by increasing the quantity of mixing water.

When an empirical formula is employed to define the composition of the concrete that should be used, it is self-evident that, if such a formula supplies sufficient fine material for a coarse aggregate having 45 per cent of voids, there will be an excess of this material with an aggregate containing 40 per cent of voids, or vice versa. In order to remedy these defects, the New Jersey State Highway Department used a formula during the 1928 season that insured the concrete mixtures used would not be either over or undersanded.

The New Jersey Formula.—The quantity of fine aggregate required for proper workability was determined and it was found that this was chiefly a function of the void content of the coarse aggregate. The formula devised required the use of sufficient fine aggregate to fill the voids in the coarse aggregate, plus the necessary working surplus. The quantity of fine aggregate thus required to be used will vary with the character of the aggregate; that is, a stone aggregate, having 45 per cent voids, will require considerably more sand than a gravel aggregate with 40 per cent voids. However, the cement contained per cubic yards of concrete will be practically the same in each case.

The use of this formula required a uniformly graded coarse aggregate, for once the proportions have been established for an aggregate having a given percentage of voids, it is quite important that this void content be maintained within reasonable limits.

In order to insure that the aggregates used would have a uniform grading and void content, the producers were made to standardize their products at once and inspectors were placed at all major production points with instructions to reject all materials that were not of the desired quality or grading. Segregation in the coarse aggregate was thus reduced to a minimum, also variation in the void content.

It was anticipated that certain producers could not furnish a uniformly graded product on account of their equipment. Provisions were made in the specifications to approve the use of such materials by requiring the coarse aggregate to be shipped in two or more sizes and the batchers to contain sufficient extra compartments to accommodate each size shipped. Definite quantities of these different sizes were then measured out for each batch, which automatically corrected all segregation and insured a uniform product having the minimum void content. This method should, and no doubt soon will, be the one generally used in proportioning aggregates.

Practically all the pavements constructed under this formula have shown marked increase in the quality of the concrete used therein as judged by its density and strength. Better results have been secured in some cases than in others for it has been found that not all cements will produce concrete having the same workability and plasticity regardless of the aggregates. When a cement does not produce a concrete mixture having these desired properties, it has been frequently noted that the contractor tries to correct this by increasing the quantity of mixing water. This has lowered the strength of the concrete in certain instances, but even then the minimum strengths secured, in most cases, have been considerably higher than the maximum strength, frequently secured a few years ago.

Data on the 1928 Work.—The quality and general character of the concrete secured during the 1928 season, by the methods of construction cited above, is quite definitely shown by the data collected during the construction of the various sections of pavement on New Jersey State Highway Route 26. Unfortunately, no service data are available on these sections on account of the age of concrete, but, to date, their condition can be considered nearly perfect for no defects have appeared.

The aggregates used in these various sections were washed gravel and washed bank sand. Several different brands of cement were used and the concrete, in general, had a good plasticity and workability. The slump was usually less than an inch. Finishing machines were used on all the sections.

During the construction of the pavement on these various sections, cores were so taken that each core represented one 1,000 sq. yd. of pavement. These cores were usually broken when 28 days old and the breaking strength reduced so that H=$\frac{1}{2}$D. A few 6 in. x 12 in. cylinders and 8 in. x 4 ft. beams were cast and tested.

The average crushing strength secured on all cores from the various sections, which were broken when 28 days old, is 5,465 lb. per square inch. The average crushing strength thus secured from each section is as follows:

Section 1—5,166 lb., Section 2—5,747 lb., Section 3—5,232 lb., Section 4—5,851 lb. The beams showed an average flexual strength of 6,424 lb.

The thickness of the pavement, general character and uniformity of this concrete is also very nicely shown on the regular date sheets used in recording the results secured on the various cores tested. A few of these sheets are reproduced below.

The crushing strength thus secured is about 1,000 lb. higher than what we were accustomed to securing a few years ago. Equally as good strengths have been secured on other pavements where broken stone was used with both washed and unwashed sands. It should not be assumed, however, that the formula used is solely responsible for these high strength tests. With this formula and method of construction followed, it has been found possible to secure a more uniform and better consistency of concrete than previously, also a lower mixing water content.

It hardly needs proving that a pavement constructed from concrete of this strength, density and uniformity will give the maximum amount of service. It certainly does, however, appear to be advisable to assume that such is the case, for if we wait to see what may happen, it is safe to assume that many of us will not be constructing pavements at that time.

Acknowledgment.—The above paper was presented at the 5th annual convention of the Association of Highway Officials of the North Atlantic States.

City Auto Deaths Down—Country Up

Automobile fatalities for the months of January and February of this year, as compared with last year, decreased considerably in the cities and increased considerably in the towns and country, as indicated by the nation-wide reports received by the National Safety Council.

These reports show that the cities had 6 per cent fewer automobile deaths this year than last year; 61 of the 90 cities that reported showed declines, or no changes at all, as compared with a year ago. But the state-wide reports received during the same period showed an increase of 11 per cent in fatal automobile accidents. In the total, there were an estimated 4,240 motor vehicle deaths during January and February of this year, as compared with 4,220 such fatalities during the same two months of last year.

There were fewer automobile accidents for February than for January of this year. The daily average for January was 70, as compared with 69 for February. There was an average death rate of only 64 for February of last year.

Only one city of population of over 300,000—Rochester, N. Y.—went through the month of February without a single motor vehicle death. Among cities of 100,000 to 300,000, there were ten on the February honor roll. They were Cambridge, Mass.; El Paso, Tex.; Erie, Pa.; Fall River, Mass.; Lowell, Mass.; Lynn, Mass.; Norfolk, Va.; Salt Lake City, Utah; Waterbury, Conn.; Wilmington, Del. Four of these cities—El Paso, Fall River, Lowell and Waterbury—also were on the honor roll for January.

That the pedestrian is the greatest sufferer in automobile accidents was again proved by the detailed analysis. About seven out of ten victims were pedestrians. More than half of these were over 55 years of age.

Motor Vehicle Registration in United States

The total registration of motor vehicles in the United States during 1928 was 24,493,124, a gain of 1,359,883, or 5.9 per cent over the number registered in 1927, according to reports received by the Bureau of Public Roads, United States Department of Agriculture, from state registration authorities. The figures include passenger automobiles, taxis, buses, motor trucks and road tractors. In addition 148,169 trailers and 117,946 motorcycles were registered.

New York heads the list for 1928 with 2,083,942 vehicles registered. California is second with 1,799,890; Ohio is third with 1,649,699; Pennsylvania is fourth with 1,642,207; Illinois is fifth with 1,504,359; Michigan sixth with 1,249,221; Texas seventh with 1,214,297; Indiana eighth with 823,806; New Jersey ninth with 758,430; and Wisconsin tenth with 742,135.

In percentage gain, Arizona ranks first with 16 per cent. The District of Columbia is second with 13 per cent. Mississippi and South Dakota each report a gain of 12 per cent. New Mexico, Alabama and Connecticut report 10 per cent; Tennessee and Texas report 9 per cent; and South Carolina, Vermont, Wyoming, North Dakota, Michigan and Delaware report 8 per cent.

Comparison of the registration total with the 1928 estimated population of 120,013,000 indicates that there is now one motor vehicle for every 5 persons in the United States; or one for every family.

From the owners of the 24,493,124 motor vehicles, the states and the District of Columbia collected in license fees, registration fees, permit charges, fines, etc., the sum of $322,630,025. This is $21,568,893 more than was collected in 1927 and an increase of more than 7 per cent.

After deducting $21,524,733 for collection and miscellaneous purposes, the balance of $301,105,292 was applied to state highway funds ($208,880,272), local road funds ($60,399,109), and to state and county bond funds ($31,825,911):

The registration totals and fees collected for all states are as follows:

State	Motor Vehicles Registered	Registration Fees
Alabama	269,519	$3,474,065
Arizona	94,372	565,806
Arkansas	214,931	3,786,004
California	1,799,890	9,292,301
Colorado	284,867	1,790,183
Connecticut	309,792	7,373,589
Delaware	51,210	928,916
Florida	352,961	4,935,995
Georgia	318,856	4,041,767
Idaho	108,154	1,626,949
Illinois	1,504,359	15,521,530
Indiana	823,806	5,751,781
Iowa	733,466	10,692,767
Kansas	533,799	5,394,448
Kentucky	304,231	4,725,258
Louisiana	264,293	4,383,634
Maine	172,638	2,763,598
Maryland	285,311	3,034,621
Massachusetts	726,295	13,919,618
Michigan	1,249,221	20,056,848
Minnesota	673,573	10,101,785
Mississippi	246,242	2,814,150
Missouri	712,965	8,765,609
Montana	126,035	1,298,828
Nebraska	391,355	3,950,788
Nevada	27,376	249,111
New Hampshire	102,644	2,070,957
New Jersey	758,430	13,569,029
New Mexico	65,737	627,751
New York	2,083,942	34,306,706
North Carolina	464,376	6,088,140
North Dakota	173,525	1,775,145
Ohio	1,649,699	11,840,258
Oklahoma	529,843	6,258,610
Oregon	248,118	6,969,221
Pennsylvania	1,642,207	27,113,777
Rhode Island	125,698	2,273,819
South Carolina	216,805	2,440,539
South Dakota	191,374	2,901,905
Tennessee	322,137	4,066,478
Texas	1,214,297	17,701,251
Utah	98,541	731,340
Vermont	86,231	2,090,960
Virginia	360,545	5,572,046
Washington	402,875	7,028,291
West Virginia	251,556	4,142,595
Wisconsin	742,135	10,774,707
Wyoming	56,336	572,570
Dist. of Columbia	126,556	473,981

Bonus and Penalty Clause in Road Contract

The specifications of the State Highway Department of New Hampshire now contains a contract time limit clause. This provision in the revision of March, 1929, is as follows:

"The Contractor shall bid whenever so requested in the special provisions of the Proposal the net time (number of working days) which he (the Contractor) will require to construct the work stipulated in the project. This number of days bid shall be multiplied by the value as set per day by the Commissioner and shall be added to the other items to make the total amount bid. For each working day that any work shall remain uncompleted after the time bid for the completion of the work the sum per day specified in the proposal form shall be deducted from the final estimate of moneys due the Contractor. In case the Contractor shall complete the work in a less number of days than bid he shall receive the sum given in the proposal as a bonus for each day that the work is finished within that time. Time shall start as provided by Section 8.2 and be computed as specified in Section 8.6 of this specification."

Observations on By-Passes and Routing

Employment of Existing Roads and Advertising Their Existence Stressed

THE rapid increase in the number of automobiles and motor trucks has caused congestion problems and "time delay" problems of serious import in the vicinity of our larger towns and cities. These problems need immediate attention. The constantly growing tendency of transportation of freight and passengers by motor vehicle will in no way assist in minimizing these congestions. In a book on "Highway Location and Surveying" by Col. W. W. Crosby, formerly location engineer of the Pennsylvania Highway Department, soon to come off press by the publishers of Roads and Streets, these problems are clearly discussed. The following paragraphs were taken from this manuscript:

The larger view of highway location must embrace the arrangement of highway routes so as to permit—really, *induce*—the use, by through traffic, of roads that will enable this traffic to reach its ultimate destination without the necessity of pursuing the ways in and out of the centers of population or activity that are provided for and bound to be congested by local traffic.

It may first be desirable to visualize for a moment the nature of this through traffic. It will be composed of two main parts—passenger traffic and truck traffic. The former may be subdivided into pleasure and business, but seldom will it be necessary to make that differentiation for the purposes in hand.

For all passenger traffic the advantages of by-passing congested sections will lie in the avoidance of danger (real or apparent), the pleasure of better scenery, and the satisfaction of apparently making better time. If these seem to be enjoyed, the matter of distance or of grades is of little or no consequence.

To the truck traffic by-passes, if they seem to offer relief from congestion, with its dangers and delays, will appeal if again excessive distance and grades are not the price.

The traffic to be by-passed should be again regarded, in the consideration of its routing, as divisible another way into at least two parts. One is that whose origin and destination are located within a relatively short radius from the congested center. Such a fraction will call for a by-pass quite close to the most thickly congested area.

A second fraction would be that traffic coming from a considerable distance and headed for a destination on a corresponding distance beyond the center. Such traffic could most readily use a by-pass such a maximum distance out from the center as would not, in effect, destroy the directness of the main route for this traffic.

Other fractions may be conceived, intermediate between the two mentioned, though circumstances will for the present have to decide how many of these fractions shall be provided for and indeed whether or not any such fractional consideration shall be attempted.

As a general rule, it perhaps may be stated that the importance of any fractions will be in proportion to the size of the congested area, the degree of congestion, and the amount of the through traffic.

Other physical circumstances may affect the problem, such as, in most cases, the topography, the trend of developments in and about the area now to be avoided, and perhaps even the historical, sentimental, or other more or less intangible factors that may enter.

It should, perhaps, be noted that often, as in these cases, by-passes do not mean many miles of new layouts nor even of new construction, but merely the adaptation of existing routes and, perhaps, even more particularly, their advertisement.

Many have doubtless attempted to follow circuitous routes, by-passing congested centers, by means of minute descriptions furnished by automobile clubs. Notwithstanding the care taken in the preparation of the directions—usually printed in small type to be compact and usable in a moving car—such experiences have often been most unsatisfactory. The directed turns, when located, often look unattractive or even repellent. Frequently there is great difficulty in identifying the turns from lack of proper street names or other signs, and if one is not proceeding unusually slowly in approaching them the frequent result is to miss the turn that is not obvious. Almost always one emerges from the maze confused and resentful at its lack of clearness, the time required in it, and the missing of the scenery from concentration on the directions, even if thankful for having avoided the congestion known to exist on the more obvious route through the latter.

Even park roads should have a directness apparently consistent with their objective and their meanderings seem justified by circumstances. Scenic roads should be as direct as conditions apparently allow between their objectives, though tangents in neither park nor scenic roads may not be called for nor even allowable unless obviously warranted by conditions.

Motor traffic exemplifies a normal human tendency—to "follow the crowd." Many motorists "do not believe in signs." Sometimes they can hardly be blamed for this where the signs are too elaborated, too complicated, and too indistinct for the "runner" to "read." But, on the other hand, intelligent motorists with the purpose of reaching a destination, if fairly advised by legible signs and evident opportunities for avoiding congestion, will watch for chances to leave the crowded line and avail themselves of by-passes that promise advantages.

By-pass departures from the main route must, by the details of their location at the junction, invite traffic, and signs at the point should clearly explain the attraction (see also the notes on signs). Inconvenient or blind departures will offset any practicable arrangements of sign-posting and defeat the purpose just as a meandering path heading apparently in the wrong direction in the beginning, even though the path eventually reaches the goal, confuses if it does not actually repel travel unfamiliar with it and seeking a destination.

The automobile associations try to help motorists to avoid congestion by printing and distributing cards giving minute directions for the route to be followed around such centers. But reading and following these directions is often arduous and unsatisfactory, often particularly when the reader at the same time wishes to observe the scenery and other interesting things along his route. For such by-passes every effort should be made by location and by simple sign-posting to make the route to be taken as obvious as possible.

Within the past year or two, a change has become evident in the mind of many individuals and in the case of several groups or even municipalities —where formerly there existed a very strong desire, not to say insistent prejudice—to have the improved surfacing of the state highway route laid immediately by the door of the private residence, along the main street of the village or to the central square of the town, there is now considerable support being given by the individual and by the public to the engineer's statement that such location is often most undesirable.

The noise, dangers, and other annoyances of motor traffic, which is largely from other sources rather than of local inception, have converted many laymen to the professional ideas of locating, for the best interests of all concerned, the modern roadway at least a reasonable minimum distance from

The Altoona, Pennsylvania, By-Pass Problem

dwellings, and otherwise than along village streets where local business must be transacted or than through the hearts of the towns.

Large cities now are demanding by-passes for the through traffic of interstate or similar routes of more than local importance.

Is not the deduction inescapable that future steps imminent in location solutions are those of regarding a certain portion of the whole traffic as through; of determining the termini of this through traffic; and then, as soon as its importance shall so warrant, of locating direct routes for that traffic between these termini, regardless of existing but less direct and therefore unsatisfactory present routes?

Such procedure seems inevitable if traffic developments for the next decade prove to be at all along the lines of those of the last. The consideration may involve regional planning, which of itself already threatens many areas of the east, and in its solution again suggests conclusions as to future highway location similar to those above expressed.

It is probably now too early safely to jump to such conclusions, and the location problems of today must still be solved mainly in the light of today's needs. The new position suggested for viewing them must be reached gradually, probably, as in all highway progress so far, somewhat uneconomically but conservatively and safely. The demands of today are for results—imperfect or temporary as they may perhaps be, but actual. And the American public has no compunction about scrapping once useful construction for better whence once the improvement is seen to be justifiable. It may be well, however, for those conducting the highway work to lead it rather than to be driven.

Complete Highway System in Paraguay Proposed.—Two plans, incorporated in bills last year, for beginning on a large scale a complete system, of public highways in the interior of the country await the consideration of Congress.

Traffic Problem to Be Studied

As chairman of the committee on traffic of the American Road Builders' Association, M. O. Eldridge, Assistant Traffic Director, Washington, D. C., has named sub-committees to study every phase of the traffic problem during this year. Their findings will be presented at the Association convention and road show in Atlantic City next January and made available for general use.

The collection of accident statistics and analysis of accidents will be in charge of a group headed by Burton W. Marsh, Pittsburgh, Pa., which will also study traffic flow maps and spot maps, the necessity for uniformity in state and city vehicle laws and the question of where and why parking should be restricted, or eliminated entirely.

All questions dealing with regional planning will be in charge of the group headed by Dr. J. Gordon McKay, Cleveland, O., a former Bureau of Public Roads official and highway expert. His committee will study which streets are to be designated as through streets, which for one-way traffic, which classes of streets should be paved, widened or zoned for special classes of traffic, relation of pavement, design and type of traffic volume and loads, weights and loads for different classes of vehicles and necessity for zoning.

Streets will be classed by type of traffic as quantitative; local or foreign; or qualitative; trucks, automobiles, buses and street cars.

The traffic signals and signs and street lighting study is in charge of Wm. S. Canning, Philadelphia, Pa. When and where traffic control devices are needed will be based on volume of traffic, its character, variation and direction as to whether it warrants the use of warninig signs, flashing beacons, boulevard stop signs, isolated traffic control, officer control or complete automatic signal installations.

The amount of street lighting called for by maximum volume of traffic on two lane or wider streets, one way or both, with and without car tracks will be investigated, as will location and arrangement of traffic lights, desirable types of timing equipment, maps of signal installations at unusual intersections, three, five and six-way, sharp angle intersections and traffic circles with varying intersections.

The fourth sub-committee will study traffic law enforcement and drivers' licenses. The issuance of licenses by examination and driving test, suspension and cancellation for misdemeanors or felonies, and elimination of mental and physical defectives are objectives where progress made will be immediately reflected in greater safety of highways, reduction of traffic fatalities and accidents and facilitated movement of the nation's traffic.

The Constructor's Obligation

Changes Needed to Improve Conditions in Construction Industry

By S. M. WILLIAMS

Manager of Engineering Construction Division of Associated General Contractors of America

DO we realize our obligation to industry and specifically to our own industry?

How many of us realize that we are a part of an industry that is charged with an annual expenditure of approximately seven billion dollars of public and private money?

In asking that question, I do not confine it to constructors, but include every ally of the construction industry.

Unfortunately, we have frequently failed to realize that in attempting to serve the public, the construction industry has more than simply the question of profit or loss to consider.

The Definite Obligation of Cooperation.—Until the construction industry, including every element, realizes a definite obligation of cooperation in order that the public may, in so far as possible, be assured of skill, integrity and responsibility, when awarding a construction contract, it has no right to expect or demand recognition or consideration of the public.

The construction industry now realizes the serious consequences from a deliberate disregard for obligation which has encouraged a lack of consideration for those engaged in, at least, certain branches of construction. This situation for some years, in highway construction, developed little if any serious thought upon the part of public officials. They were following lines of least resistance. They considered the public fully protected in the surety bond guaranteeing the fulfillment of the contract in case of default or failure of the irresponsible or over-extended constructor. They overlooked, or did not realize, that the bond did not protect the public from loss in the use of the improvement. This loss has been known to exceed the original cost of the improvement.

Bidding Practices.—The disregard of constructors for their own industry as shown in their bidding practices has, for many years, developed in the minds of public officials a lack of interest as to whether the constructors made any money in their work. Why should a public official be interested in the welfare of a constructor, if the constructor does not have backbone sufficient to protect himself. On the contrary, the public official has said "we do not want you to lose money on our contracts, but if you insist we can not prevent you from doing what you should know is wrong."

In some states, notwithstanding, public officials have urged the constructors to include a legitimate profit in their bids, the constructors have ignored the warnings, and they have been warnings, because public officials are now becoming annoyed if not alarmed at the present low level of bidding. During the annual meeting of the American Association of State Highway Officials, in Chicago, a number of officials said to me "Where is your industry headed?" One of the officials said, "it is going to H—l." I did not attempt to deny it.

The reason for the inquiry by the highway officials was the present low level of bidding which was, or would force their estimates to the same level, notwithstanding they knew there was no profit, and frequently loss, in the execution of the contracts at such prices.

Bids Below Engineers' Estimates.—One highway official, who is not only one of the oldest in service, and considered one of the ablest in the entire country, recently said, "Williams, my chief estimator has been with me for a long time, and from experience I consider him as competent as any estimator I know in public or private work. The bidding on our work has reached such a low level, that it not only reflected upon our estimates, but the difference between our estimates and the actual bidding was so great that our commissioners ordered me to discharge the estimator. It is needless to say we have lowered our estimates."

With the exception of where the engineers' estimates are published, the estimates have been based upon what they considered conservative and intelligent estimates and fair prices for awarding the work. As an example, in three states in the work for the U. S. Bureau of Public Roads, all of the highway construction work last year was awarded at $3,444,933.00 below the engineers' estimates. This means that the construction industry was robbed of what the public officials considered a fair and legitimate profit.

It seems unnecessary to remind you that once the engineers' estimates are reduced to present level of bidding, it will be more difficult to raise them. The industry realizes the seriousness of false and loose credit practices resulting in a large element of irresponsibility and inexperience which faces those responsible, in the award of public construction contracts, and which in many sections of the country has cost the public vast sums of money.

Constructors Responsible.—I have been as severe in the charges of bad practice upon the part of those allied with the construction industry as any one, and so far as I am able to remember, I would not detract one single statement, but after another year of close study of all practices in the industry, am ready to say definitely, the responsibility is upon the shoulders of the responsible and experienced constructors.

So long as you responsible and experienced constructors have not sufficient interest in your industry to protect it by setting an example for sound business ethics, you are not entitled to demand it from others.

So long as you are not sufficiently interested to sell the importance of your industry to your communities, and your bankers, you have no right to expect recognition for your industry.

After making a similar statement to what I have just stated, to one of our chapters I received a letter from a prominent constructor engaged in building construction. He said "everything you said not only applies to the public works man, but to the private operators as well, and to show you the contempt in which the business of construction is held I had an analysis made of last year's building permits in our own city and find that $18,753,502.00 worth of permits were taken out for day labor operations and only $8,827,039.00 worth of permits were taken out for contract operators. You are exactly right in saying we have got to sell the industry to ourselves and to our public."

Let me quote from a prominent banker who recently said in a letter. "The history of difficulties encountered by banking institutions where financially and practically unprepared constructors have assumed work beyond their ability to carry out, by reason of under-bidding concerns amply able to successfully carry out their obligations, has been a source of criticism among the banking interests and is sometimes the cause of loss, and is a condition which should be remedied." What consideration should that banker have for an industry when it permits such conditions to continue?

So long as you are willing to purchase your contract bonds from surety companies who are guilty of the un-

ethical practices with which they are charged, you have no right to criticize the surety companies.

So long as you are willing to purchase construction equipment from those whose greed for volume of business exceeds their interest in the welfare of the construction industry, you are encouraging a continuance of such practices.

So long as you are willing to purchase construction material from those whose policies for extension of credit are based upon the lien law rather than stability of the buyer, and who refuses to cooperate in the stabilization of the industry of which they are a part, you, as responsible and experienced constructors have no right to expect a discontinuance of such practices.

Standardization of Credit Terms.—During the last year we have had numerous conferences with manufacturers and distributors of construction equipment and materials upon the subject of false and loose credit in connection with sale of equipment. From these conferences, came certain recommendations from the manufacturers for standardization of credit terms. A large number of manufacturers have individually adopted credit policies as conservative, or more so, than the recommendations of the manufacturers' 1928 conferences. There was, however, considerable doubt as to the sincerity of the constructors, and whether, when it came to purchasing additional equipment, they would not demand of the manufacturer and distributor, the same unreasonable credit terms as demanded in the past.

We have stated, and believe we were justified, that the responsible constructors were sincere in asking the manufacturers and distributors for cooperation in clearing the construction industry of the economic conditions therein.

Surety Division Formed.—One very important step towards a more cooperative activity and discontinuance of unfair practices, where they may have existed, has been the formation of the Surety Division of the Affiliated Bureau of the Associated General Contractors.

The membership in the Surety Division of the Affiliated Bureau, is a recognition that sound business ethics and fair trade practices should be the policy of the entire construction industry including its allies.

The purposes of the Surety Division are:

To provide closer contact between the construction industry and surety companies.

To create better understanding and greater appreciation of mutual problems.

To promulgate joint action of direct benefit to the construction industry and surety companies.

One of the first actions of the Surety Division was the unanimous adoption of the following resolution:

"Now, Therefore, Be it Resolved, That the undersigned surety companies, constituting the Surety Division of the Affiliated Bureau of the Associated General Contractors, in formal meeting, assembled, unanimously declare themselves committed to the principle of pre-qualification, now approved and practiced by the United States Bureau of Public Roads, and respectfully recommend to all State and Federal Officers, and Legislative Bodies, the consideration and enactment of statutes requiring constructors, as a prerequisite to the right to bid upon public works, to demonstrate to the appropriate public official, their qualification for the performance of the obligation they propose to assume."

The problems of construction as they affect the interest of the public and those responsible in the award of public construction contracts, have become national because constructors are no longer confining their activities to local, county or state work. The increasing tendency of the constructor in public construction work, to cover more than one community or transfer his activities from one state to another emphasizes the importance of closer co-operation between constructors and public officials in order that the public may be assured of skill, integrity and responsibility in contract performance.

The definite consideration of Skill, Integrity and Responsibility in the award of construction contracts assures the public that their interests are safeguarded. The award of a contract on price without definite consideration of all the qualifications of the bidder is contrary to sound business. It is gambling with the interest of those for whom the improvement is planned to benefit.

A surety bond guaranteeing performance of contract,—important as it is, and I believe is destined to become more important, so long as its use is voluntary and not mandatory,—will not repay the tremendous losses to the public from delays in the use of the improvement.

Pre-qualification of Bidders.—Self-preservation, if not self interest, dictates in our private affairs that we pre-qualify those to whom we intrust responsibilities. We ask what are his qualifications, and pre-qualification is the first step, providing they have not in some manner, already pre-qualified.

I am not overlooking the fact that in a number of states, there has been an effort to safeguard the interests of the public in qualifying to some extent the low bidder after bids have been received. We believe this was a step forward in recognition of the interest of the public. We realize however, that when a certain constructor is known to be a low bidder, pressure in the award of the contract from political and commercial sources frequently embarrasses the awarding official in doing what he knows to be for the best interest of the public. Under such pressure, thousands of public construction contracts have been awarded throughout the United States which have cost the public many millions of dollars.

For the reasons I have already stated. The construction industry believes that the interests of the public in public construction, of any character, will be best served and more thoroughly safeguarded by pre-qualification of the bidder before he is given the plans upon which to bid. Pre-qualification is not urged for the benefit of any one type of constructor. Authorities including surety companies tell us that over extension beyond the limitation of the constructor, both large and small is the principal cause for default and failures. We believe that pre-qualification will protect the constructor so that he will progress within his limitations in proven experience, responsibility and integrity.

We have enough confidence to believe there is a growing appreciation for the construction industry by not only the responsible and experienced constructors, but by the public officials, bankers, surety companies, manufacturers and distributors of construction equipment, producers and distributors of construction materials. All that it needs is a definite example of sound business ethics by the responsible and experienced constructors, followed by a demand that such ethics be followed by those desiring recognition.

One of the recommendations of the recent A. G. C. Convention in Chicago was definite action toward the discontinuance of publishing unit bid prices by public officials, trade publications, surety companies, surety agents or other agencies where the publishing of such prices encourages careless and unintelligent bidding.

The Opening of Bids.—Speaking of intelligent bidding, I would suggest that all bids upon public construction work be filed by registered mail at least three to five days before opening and then opened in public. That bids could not be withdrawn after once filed for any reason except final withdrawal. I realize this would be an innovation but I believe it would result in more intelligent bidding.

I would also recommend that the certified check be mailed separate but accompanying the bid and that it be cashed when received.

In conclusion, let me impress upon you that you have an industry worth working for and that we have no right to criticize unless we are willing to be criticized.

Acknowledgment.—The above paper was presented at the 9th Annual Convention of the Associated Pennsylvania Constructors.

The Rate of Traffic Increase Exceeds Improved Highways

Interesting Facts Based on Recent Traffic Census in New Mexico

By R. W. BENNETT
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IN setting one's self for an hour's light reading one ordinarily does not pick up the World Almanac or a Report of the Congressional Committee on Taxation. Yet, figures in certain combinations and viewed from certain angles, particularly from the standpoint of traffic and transportation form an intensely interesting subject and present a definite problem for immediate solution. For traffic is growing more rapidly than highways are being improved.

Average Count Desired.—In taking the annual traffic census this year, the State Highway Department selected the week of Sept. 30th to Oct. 6th, almost one month later than the 1927 count. The reason for this was threefold: First, to avoid, if possible, the wet weather encountered during the August and September counts in 1926 and 1927; second, to obtain an average count rather than a high count, such as would ordinarily be obtained in August and September which are "peak" months from the standpoint of traffic; and third, a corollary of the second reason, to obtain the ratio of foreign traffic to local traffic during an average period rather than during a "peak" period. The results of the census were in the main satisfactory and upheld observations and opinions based on previous counts.

One hundred and fifty separate counts were taken by 90 enumerators. The Federal highway system and principal state roads were covered in the week's count. A table containing the details of the census at most of the stations accompanies this resume.

Some generalities in regard to the census are of interest:

22 Per Cent Increase in Traffic.—Notwithstanding the fact that the counting was done nearly a month later than last year, a substantial increase is noted. Traffic as a whole increased 22 per cent over 1927. Local travel increased 29 per cent and foreign travel 9 per cent. The percentage of foreign cars dropped from 35 per cent to 32.2 per cent for the reason that the count was taken in an average rather than "peak" season.

This holding up of the tourist traffic volume is significant—it means that one-third of the travel over New Mexico roads throughout the year is foreign traffic. It means that the tourists' gasoline nickels amounted to $600,000 this year—half of the annual maintenance costs.

From an inspection of several stations selected at random, it would appear that motor vehicular travel is heaviest over the week-end and that the traffic curve for the week is at the lowest point at midweek. In order of traffic volume the days of the week are: 1, Sunday, 2, Saturday, 3, Tuesday, 4 and 5, Friday and Monday—about equal, 6, Thursday, and 7, Wednesday—the lightest of all.

Peak Hours of Traffic.—Traffic is heavier in the afternoon than in the morning. This is more particularly true on Saturday and Sunday. The hours between 5 and 6, between 4 and 5 and between 6 and 7 P. M. are the "peak" hours. The hour from 8 to 9 A. M. gets the heaviest traffic among the morning hours. Traffic reaches a steady basis during the midday hours. The traffic curve shows a rather steady increase from midnight till midforenoon, then a rather flat trace till midafternoon, a sharp increase till 7 or 8 P. M. and a declining curve from then till midnight again. Tourists travel at earlier and at later hours than home folks. Relatively speaking, the percentage of foreign cars recorded was greater during the morning hours prior to 8 o'clock and in the evening hours after 8 o'clock. This does not mean a heavier traffic volume during these hours—just more tourists in proportion to local travelers.

Passenger cars constitute the bulk of motor vehicular travel—88 per cent of the whole. Naturally, the percentage of foreign cars of this class is greater than the foreign car per centage of the entire count, being 34½ per cent against 32.2 per cent.

Bus traffic as a whole constitutes but 1 per cent of the enumeration; however, at certain stations, bus traffic is more of a problem. For example, on the Lamy road south of Pankey's Gate buses form 13 per cent of the traffic. On U. S. 85 near the same location buses represent 4 per cent of the travel on this transcontinental highway.

Truck Traffic.—Truck traffic is more imposing. All trucks form 11 per cent of the count; light trucks—1 and 2-ton—constitute 8 per cent of the volume; heavy trucks—over 2 ton—make up over 3 per cent. Between Gallup and Gamerco, trucks formed 22 per cent, nearly one-fourth of the entire count, 12 per cent being light trucks and 10 per cent heavy trucks. This shows the necessity of the paving placed between these cities. West of Silver City, the truck traffic is even heavier, being 28 per cent of the total volume, about equally divided as to light and heavy.

Horses are still encountered on the highways. In terms of a proportion, horses and horse drawn vehicles are to motor cars as 1 is to 24.

One thing of particular interest is noted in comparing the counts of 1927 and 1928. While travel has increased in a normal way on the main arteries of travel, traffic on several secondary roads took enormous jumps. The improvement of secondary state roads, under the greatly increased program of state aid construction, has doubled and tripled the volume of traffic on some of these highways. This shows that the auto is all warmed up and raring to go wherever you build it a road. Some instances of this are noted on the following roads:

Road	Traffic Station	1927 Daily Aver.	1928 Daily Aver.	Increase Per Cent
U. S. 64	State Line	42	104	146
S. H. 3	Costilla	66	177	168
S. H. 6	Moriarty	17	49	197
S. H. 2	Encino	53	*208	302
S. H. 35	Thoreau	23	141	513

*Includes traffic over new Villa Nueva road in 1928.

Heavy Traffic Roads.—Ten counting stations indicated a volume of traffic in excess of 1,000 motor vehicles per day. These ten stations are recorded below, in order, and with comparative 1927 counts where available:

Order	Road	Traffic Station	1928 Daily Aver.	1927 Daily Aver.
1	U. S. 85	Barelas Bridge	3 451	2,731
2	U. S. 80	Mesilla Park	3,133	1,830
3	U. S. 666	Gallup-Gamerco	2,192	1,157
4	U. S. 366	N. Roswell City Limits	1,579	
5	S. H. 2	Cavern Rd. Jct.	1,371	1,471
6	U. S. 80	Mesquite	1,347	*1,572
7	U. S. 470	University Heights-Albuquerque	1,346	712
8	S. H. 2	Roswell City Limits at McGaffey St.	1,161	
9	U. S. 80	Hacklers Store-Las Cruces	1,086	
10	S. H. 13	E. Roswell City Limits	1,065	1,294

*Count taken at Anthony in 1927.

The first two stations in order above maintain the same relative positions as last year. No. 3—Gallup-Gamerco—moved up from 6th to 3d position (rain in 1927 in this locality). No. 4 is a new count this year. No. 5 occupied No. 4 last year. No. 6, the Mesquite

count is a new count this year; it was taken at the state line at Anthony last year and had 3d place in 1927. The University Heights count, No. 7 in order, was not in the 1,000 class last year; traffic increased nearly 100 per cent at this station. Nos. 8 and 9 are new counts this year. No. 10 had No. 5 position last year.

As would be expected, sections of highway sustaining the heaviest traffic are located near the larger cities and through thickly populated communities. Traffic in the Pecos Valley which shows some falling off from last year, is readily accounted for by the taking of the count on month later, thus missing the vacation season traffic to the Cavern. Actually this traffic was much heavier in 1928 than in 1927.

Traffic Over Principal Routes. — Eighteen principal routes are shown below in the relative order of average volume of travel indicated by the 1928 census:

Order	Road	Control Points	1928 Aver.	1927 Aver.
1	U. S. 80	El Paso-Las Cruces-Lordsburg	1,189	726
2	U. S. 666	Gallup-Gamerco-Shiprock	*788	443
3	S. H. 2	Roswell-Carlsbad-Pecos	777	748
4	U. S. 85	Raton-Santa Fe-Albuquerque-Los Lunas	745	822
5	U. S. 66	Los Lunas-Gallup	556	†299
6	U. S. 470	Albuquerque-Tijeras-Willard	504	419
7	U. S. 366	El Paso-Roswell-Clovis	412	426
8	U. S. 85	Las Cruces-Socorro-Los Lunas	388	199
9	U. S. 485	Raton-Taos-Santa Fe	378	362
10	S. H. 44	Farmington-Cuba-Bernalillo	338	195
11	U. S. 70	Clovis-Vaughn-Socorro-Quemado	312	328
12	S. H. 2	Espanola-Chama	312	158
13	U. S. 385	Raton-Clayton	306	209
14	U. S. 66	Genrio-Santa Rosa-Romeroville	263	113
15	S. H. 2	Roswell-Vaughn-Santa Fe	193	116
16	S. H. 18	Clovis-Tucumcari-Clayton	171	278
17	S. H. 3	Vaughn-Carrizozo-Tularosa-Las Cruces	145	84
18	S. H. 11	Columbus-Deming-Silver City-Alma	131	303
19	S. H. 39	Logan-Mosquero-Roy-Springer	100	208

*Unbalanced by heavy count between Gallup and Gamerco. †Rain last year.

Comparisons with last year's stations above are, in several instances, influenced by unbalanced counts in 1927 caused by unusual bad weather conditions which held sway in several parts of the state that year while the census was being taken. This caused spotted counts and abnormal traffic on many roads.

Foreign Traffic.—Gateway counting stations, as might be expected, indicate a larger percentage of foreign cars passing these points than interior stations. The great number of tourists in proportion to local traffic at some of these points is of interest:

	Foreign Traffic Per Cent
Raton Pass, U. S. 85	71
Mora Junction, U. S. 85	60
Endee, U. S. 66	56
State Line, U. S. 385	68
Glorieta, U. S. 85-66	57
Manuelito, U. S. 66	69
Newman, U. S. 366	54
Carlsbad Cavern Road	60
State Line near Tatum, S. H. 18	65
East of Clovis, U. S. 70	55
East of Lordsburg, U. S. 80	92
Quemado, U. S. 70	79
Mesquite, U. S. 80	50

As stated before, in spite of the fact that the census was taken a month later this year, the increase in volume of traffic over last year is 22 per cent. Doubtless the actual gain is nearer 30 per cent. Tourist traffic gained 9 per cent in the comparison, with an actual estimated gain of at least 20 per cent.

Last year, the tourist questionnaire distributed by the Department brought in sufficient information upon which to base an estimate of the number of out-of-state cars visiting New Mexico during that year, the number of visitors and estimated expenditures in the state.

Applying the normal increase of 20 per cent in tourist traffic to the 236,600 visiting cars of 1927, and we have 284,000 estimated tourist cars in 1928. The average number per car is three and the average expenditure per person was $23.00 (as determined from information obtained last year on the questionnaire cards). On the basis of these figures, we are able to estimate 850,000 auto tourist visitors during 1928 with an attendant volume of business in the neighborhood of $20,000,000.

Unquestionably good roads bring tourists and tourists bring business. A certain percentage of these visitors remain to become citizens and to invest their money in local enterprises and property.

The big idea, then, would be to increase this percentage of substantial home seekers and potential capitalists.

How else can we do this except by a broad highway policy, a comprehensive program of road construction and maintenance and attendent state development?

Early Survey of Pan-American Road Route Wanted

Providing for the cooperation of the United States Government in a reconnaisance survey of the route and cost of an inter-American highway, Representative Cole of Iowa has introduced a resolution in the House of Representatives appropriating $50,000 for a field study of this international project.

The resolution as presented authorizes the Secretary of State to cooperate with the several governments that are members of the Pan-American Union in the initial step of a task which has engaged the attention of statesmen for decades past. His action is in line with recent developments which give more practical promise of the realization of inter-American highway communication than has been evidenced since the plan first was broached years ago.

President Coolidge in his recent message to Congress reiterated his previous attitude favoring not only the proposed inter-American highway, but such assistance as the United States Government, by reason of its greater experience, can render in the furtherance of a general highway program for the several countries of Central and South America.

In his resolution Representative Cole takes cognizance of the action of the Sixth International Conference of American States, which at Havana last February went on record as entrusting the Pan-American Union with the preparation of projects for the construction of the highway.

At the last meeting of the Governing Board of the Pan-American Union, this task was assigned the Pan-American Confederation for Highway Education, of which Dr. L. S. Rowe, director general of the Pan-American Union, is chairman.

The Confederation has initiated steps toward a field study of the route and related economic factors, having inquired of the Central American States if its cooperation would be welcomed.

Representative Cole's resolution in effect vitalizes a joint resolution approved by the Congress at the last session in which the president was authorized to direct the several agencies of the government to cooperate with the members of the Pan-American Union, which includes all the countries of Latin America, in a study of the proposed highway. This resolution, however, failed to appropriate funds for the contemplated action, and it is this omission that the Cole resolution corrects.

It provides for immediate action on the part of the Secretary of State when any one or all of the Southern nations shall have initiated a request or have signified a desire for cooperation in this monumental project.

Mr. Cole's resolution specifies that the survey shall develop the facts as to the feasibility of possible routes, the probable cost, the economic service such a road would render to the nations, and such other information "as will permit a visualization of the whole undertaking of financing and building an inter-American highway or highways."

The resolution was referred to the committee on Foreign Affairs, and it is believed that it may be brought up for discussion and possibly passed well before the close of the present session of Congress.

To those who are taking a lively interest in the promotion of the highway, early action is deemed expedient, inasmuch as the problem of inter-communication by means of highways through the countries of Central and South America will be one of the principal questions for discussion at the Rio de Janeiro Conference in June, 1929, when the several governments will send delegates to the Second Pan-American Conference on Highways. Congress at the last session authorized President Coolidge to name the United States delegates to the Conference.

Motor Vehicle License Fees and Gasoline Taxes

Equitable Distribution for Highway Purposes

By HENRY R. TRUMBOWER
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WITHIN the present generation a new source of public revenues has been tapped. At the beginning of this century there were no such revenues as "motor vehicle license fees." In 1901 the state of New York collected $954 from the licensing of automobiles and in 1903 the two states, New York and Massachusetts, reported a collection of $26,865 in motor vehicle license fees. Twenty-five years later, in 1928, the fees collected from the licensing of motor vehicles in the United States amounted to $322,630,025.* Every state and the District of Columbia, since 1913, has been collecting this type of a tax.

Development of License Fees and Gasoline Tax.—The gasoline tax is of more recent origin. The first gasoline tax law was enacted by Oregon in 1919. Since then other states followed so that at the present time every state in the union has on its books a law which seeks to raise revenues by placing a tax on the sale of gasoline used primarily for highway purposes. In 1921, $5,302,259 was collected through this type of a tax effective in 13 states. In 1928 the gasoline tax revenues of all the states amounted to $304,871,766. It is not appropriate at this time to discuss the question in all its details as to why the gasoline tax became so popular in so short a time. This general theory, however, underlies the development of the gasoline tax principle; that the people who use the roads should pay for them and that a tax on gasoline measures to a certain extent the wear and tear on a highway from an automobile passing over it.

A great deal could be said with respect to the methods and policies followed by the several states in raising revenues through the motor vehicle license fee system and through the gasoline tax. That would be a task in and of itself. Suffice it to say that no two states appear to have similar or identical laws designed to raise revenues from these two sources. In the United States there is being raised a sum of well over half a billion dollars, $627,501,791, to be exact, through the application of motor vehicle license fees and gasoline taxes. The problem to be discussed for the moment relates to the distribution of these funds. What happens to these 627 million dollars collected from owners and operators of automobiles, trucks, busses and taxicabs which are using our city streets and rural highways? What principles are followed in the distribution and use of these funds? Are the motorists and those comprising the general public and the taxpayers receiving fair and equitable treatment in the present distribution practices?

*Data and figures used herein are taken from the files and publications of the Bureau of Public Roads, U. S. Department of Agriculture, Washington, D. C.

Table I
Total Revenues from License Fees and Gasoline Taxes

Year	Total Expenditures for Highway Purposes	Amount	Per Cent, Ratio to Highway Expenditures
1921	$1,036,587,722	$127,780,913	12.3
1922	*	163,971 265	.....
1923	996,781,038	225,784,931	22.6
1924	1,181,521,115	305,226,742	25.8
1925	1,288,939,707	406,648,561	31.6
1926	1,300,545 632	475,905,583	36.8
1927	1,350,000,000†	559,899,945	41.4
1928	1,400,000,000†	627,501,791	44.6

*Data lacking. †Estimates.

Expenditures for Highway Purposes and Motor Vehicle Revenues.—There are a great many people who believe that the motorist, through license fees and gasoline taxes, pays for almost all of the highway improvements made each year. When suggestions are made to raise gasoline tax rates or advance the license fees a wave of objection arises and it is claimed by many that too much is already being contributed by the motorists. As a matter of fact the states and counties and local road units under whose jurisdiction the direct expenditures for highway improvements are made spend for such purpose more than twice as much each year than is being collected from motor vehicle owners and operators in the shape of license fees and gasoline taxes. Such road expenditures do not include any of the outlays for the construction and maintenance and repair of city streets.

The proportion of total expenditures for highway purposes raised from motor vehicle revenues has been increasing from year to year. In 1921, the first year that data of this kind were gathered, the total revenues derived from license fees and gasoline taxes constituted but 12.3 per cent of the total expenditures made during that year for highway purposes. In 1926, the total highway expenditures amounted to $1,300,545,632, and the amount of money collected as motor vehicle licenses and gasoline taxes was $475,905,583, or 36.8 per cent of the expenditures. During the past year, 1928, it is estimated that there was spent approximately $1,400,000,000 for highway purposes; the total revenues from license fees and gasoline taxes reached the sum of $627,501,791, or 44.6 per cent of highway expenditures.

Even if all of these motor vehicle revenues were available for use in making highway improvements and meeting highway expenditures, the amount collected from motorists through these two methods is still less than half of our annual highway bill.

Registration, License Fee and Gasoline Tax Data.—A study of these data shows that there has been a steady increase in the total motor vehicle revenues. The amounts represented by license fees and by gasoline taxes are shown in Table II.

Since 1921 to 1928 there has been a steady increase in the amount of license fees collected; from $122,478,564 to $322,630,025. This increase is principally due to the increase in the number of motor vehicles registered. But a part of the increase in the amount of license fees collected is also due to an advance in the average license fee paid per vehicle throughout the United States. In 1921 the average fee was $11.70 per vehicle and in 1928 it was $13.10. The introduction and spread of the gasoline tax, however, accounts for most of the increase in total motor vehicle revenues. In 1921 only $5,302,259 was provided by this new type of revenue; by 1928 the gasoline tax contribution had reached the sum of $304,871,766.

Gasoline Tax Revenues.—The gasoline tax has come to play a larger and larger role in raising funds from motor vehicle owners and operators. In 1921 it constituted but 4 per cent of the total motor vehicle revenues. It increased steadily every year, both in amount and in proportion till it reached 49 per cent of the total contributions in 1928. According to these figures and the

Table II

Year	Total Number of Motor Vehicles Registered	License Fees Amount	License Fees Per Cent of Total	Gasoline Tax Amount	Gasoline Tax Per Cent of Total	Total	Average per Motor Vehicle
1921	10,463,295	$122,478,654	96	$ 5 302,259	4	$127,780,913	$12.20
1922	12,238,375	152,047,823	93	11,923 442	7	163,971,265	13.30
1923	15,092,177	188.970,992	84	36,813,939	16	225,784,931	14.40
1924	17,591,981	225,492,252	74	79 734,490	26	305,226,742	17.40
1925	19,937,274	260,619,621	64	146,028,940	36	406,648,561	20.40
1926	22,001,393	288,292,352	61	187,603 231	39	475,905,583	21.60
1927	23,133,241	301,061,132	54	258,838,813	46	559,899,945	24.20
1928	24,493.124	322,630,025	51	304,871,766	49	627,501,791	25.60

trend during past years it would appear that in the future the revenues derived from the gasoline tax will constitute the major part of our motor vehicle revenues.

This increase in gasoline tax revenues is due to a number of causes and conditions. (a) There has been a general adoption of this type of a tax. In 1921 there were but 13 states is which the gasoline tax was effective; in 1928 this tax was collected in every state except Massachusetts and New York. In passing it may be said that this year those two states will be collecting a gasoline tax which means that this kind of a tax is applicable in every state. (b) The rate at which gasoline sales have been taxed has increased—1 ct. per gallon was the normal rate in those states which collected this tax in 1921. At the close of 1928 seven states were charging a 5 ct. tax, 11 states a 4 ct. tax, 1 state 3½ ct., 14 states 3 ct., 13 states 2 ct. and 3 states had no tax. (c) The increased use of gasoline through a larger number of cars operated, increased use of trucks and busses, and increased mileage per vehicle have also resulted in larger gasoline tax revenues.

As shown in Table II the average amount of license fees and gasoline taxes contributed per vehicle in 1921 was $12.20 and in 1928 it had risen to $25.60, which was an increase of 110 per cent. It is evident that there is a tendency in most of the states to lay a heavier and heavier tribute upon the motor vehicle owner and operate so as to have him meet in a more direct manner the annual costs of highway developments and improvements.

Distribution of Motor Vehicle Revenues.—The immediate problem before us relates to the distribution and allocation of moneys which are collected from the two sources above mentioned and appraise the equitableness and fairness of such divisions. In order to arrive at any conclusion on the subject it is of value and interest to ascertain as nearly as is possible as to what becomes of these license fees and gasoline tax revenues after collection. In Table III this distribution is set forth in detail.

The expenses for collection and administration are costs which should naturally be charged against license fee and gasoline tax receipts. The above distribution analysis shows that 4.7 per cent of license fee revenues was a collection and administration expense and 0.2 per cent in the case of gasoline tax revenues. Thus, out of the total license fees and gasoline taxes received 2.5 per cent was accounted for by this collection and administration item. According to the detailed data of state revenues and expenditures these collection and administration costs are understated.

Only 37 states out of 49 reporting show separately any costs in connection with their administration of the licensing of motor vehicles. In the case of the states not reporting this cost separately it must be met either through appropriations from the general funds or charged to some other account. The collection and administration costs of granting automobile licenses in those 37 states which reported amounted to 5.6 per cent of the license fees collected, or an average of 74 ct. per vehicle registered. It is obvious that the percentage relationship for each of the states will vary with the level of license rates charged; where the average motor vehicle fees are $20 per car the collection and administration costs will not be twice as high as in a state where the average fee is only $10 per car. There should be greater uniformity if the collection and administration costs are reduced to a per vehicle basis. While the average cost in that case is 74 ct., these average costs range in the various states from 23 ct. per vehicle to $1.48. This great variation is due to the different ways in which the various states proceed to distribute license plates and collect fees and to the variations in character of the administration performed by the motor vehicle licensing and control bureaus of the respective states. Certain states in addition to collecting a simple license fee, maintain an elaborate system of title registration, issue driver's permits, examine applicants for driver's permits as to their ability to operate a motor vehicle, maintain and direct traffic officers for the whole state highway system. Certain states maintain a highly centralized motor vehicle license bureau which is wholly maintained out of the license fee revenues, while other states make a practice of distributing licenses and tags through county officers, in which case a large part of the administrative and collection costs may be borne by counties.

Inasmuch as almost all of the gasoline taxes are collected at the source or from wholesale distributors of gasoline and motor fuel, the costs of collection are comparatively small. The costs in the table appear, however, to be understated. According to this the collection costs amounted to only $2 per $1,000 collected (2.0 per cent). Not all of the states reported collection costs. For the 27 states that reported such costs the average was $3.60 per $1,000 collected (0.36 per cent). It is evident that this type of a tax is most economical from the point of view of collection costs, as compared with license fee revenues which cost on the average of $56 per $1,000 to collect. But it must be observed that the labor connected with the issuing of licenses and the elaborate system of record keeping is bound to be more costly.

Distribution of Funds to State and Local Highways.—Two-thirds of the total license fee and gasoline tax revenues is applied to the maintenance and construction of state highways and 18.8 per cent, or approximately one-fifth of the total revenues is applied for similar purposes to county and local roads. Consequently 85.5 per cent of these motor vehicle revenues is used for the maintenance and construction of rural highways. The relative amounts of license fees and of gasoline tax revenues used for these purposes are approximately the same for state highway systems and for local road improvements. Many different methods are followed by the several states in apportioning these motor vehicle revenues as between state highway use and local road use depending in every case upon the policy which a state has adopted relative to the responsibility for highway construction and improvements.

Funds for Bond and Interest Payments.—A part of the motor vehicle revenues, instead of being applied to current highway expenditures, is devoted to meeting past highway costs. Eight per cent in 1928 went for bond and interest payments; for state bonds it was 7.1 per cent and for county and local bonds 0.9 per cent. A much larger proportion of the license fees is used for this purpose than of the gasoline tax receipts. In recent years there is noted this tendency for certain of the states to issue bonds for highway construction purposes and provide at the same time that motor vehicle revenues be used to meet the annual interest payments and retirement payments. In 1926 only $30,513,027, or 6.5 per cent, of the total motor vehicle revenues was used in this manner, as compared with $49,445,906, or 8 per cent, in 1928. This policy has in a number of cases been to a certain extent responsible for increases in gasoline tax rates.

Funds for City Street and City Uses.—Instead of using these motor vehicle revenues wholly in the interest of rural highway improvements, a certain amount was allocated to cities for use on city streets. In 1928 $11,762,131 of license fee and gasoline tax money was diverted to cities, or 1.9 per cent of the total. About 70 per cent of these funds turned over for city use was derived from gasoline taxes and the remainder from license fees. There seems

Table III—Distribution of 1928 Motor Vehicle Revenues

Item	License Fees Amount	License Fees Per Cent	Gasoline Tax Amount	Gasoline Tax Per Cent	Total Amount	Total Per Cent
1. Collection and administration	$ 15,133,999	4.7	$ 694,601	0.2	$ 15,828,600	2.5
2. State highways	208,880,272	64.7	211,046,591	69.3	419,926,863	66.7
3. Local roads	60,399,109	18.7	57,380,901	18.7	117,780,010	18.8
4. State bonds	29,857,189	9.3	14,269,124	4.7	44,126,313	7.1
5. County or local bonds	1,968,722	0.6	3,350,871	1.1	5,319,593	0.9
6. City streets and city use	3,931,412	1.2	7,830,719	2.6	11,762,131	1.9
7. Highway traffic control	1,932,845	0.6	.....	.....	1,932,845	0.3
8. Miscellaneous purposes	526,477	0.2	10,298,959	3.4	10,825,436	1.8
Total	$322,630,025	100.0	$304,871,766	100.0	$627,501,791	100.0

to be a growing feeling on the part of cities and municipalities that they should share in the annual motor vehicle revenues, especially the gasoline taxes. The argument usually advanced in favor of such a policy by city representatives is based on the fact that municipal expenses have been greatly increased on account of the motor vehicle; that the maintenance of city streets has greatly increased and that the costs of traffic control by the police department have advanced very much because of the increasing amount of motor vehicle traffic. There is no doubt that every city could render a very substantial bill involving city expenditures caused directly or indirectly by the use of the motor vehicle. Another argument is to the effect that many motor vehicles are burdened with the gasoline tax which hardly ever, if ever, are operated over rural highways, and that revenues derived from them should in large part be credited to city governments. And there is a good deal of merit to their argument. On the other hand, traffic counts and surveys have shown that the state highway systems are used to a much greater extent by motor vehicles owned in cities than by motor cars and trucks owned and operated by rural dwellers.

In the New Hampshire traffic survey it was shown that "farm-owned passenger cars comprised 6.1 per cent and city-owned passenger cars 93.9 per cent of total passenger car traffic on the state trunk line system. Farm-owned trucks comprised 11.4 per cent and city owned trucks 88.6 per cent of truck traffic on the trunk line system."[1] In that state the trunk highway system constitutes 11.3 per cent of the total rural mileage. A similar survey in Ohio showed that the traffic using the state system is predominantly city passenger car and motor truck traffic; the farm-owned passenger cars and motor trucks constitute only 12.4 per cent and 15.5 per cent, respectively, of the total passenger-car and motor-truck traffic.[2] In that state the state highway system comprises about 13 per cent of all rural highways. A Vermont traffic survey showed that the state-aid system, which includes 30.6 per cent of the total mileage of rural roads, carried a traffic of which 10.1 per cent comprised farm-owned passenger cars and 89.9 per cent city-owned passenger cars. City-owned trucks comprised 81.1 per cent of the motor truck use of the same systems and farm-owned trucks 18.9 per cent.[3] These figures and the results of other traffic surveys show that the high-type improvement and maintenance of state highway systems is, therefore, primarily the result of the demand for highway service by city motor vehicle owners. It should also be borne in mind that on these state highway systems of the country, which constitute approximately 10 per cent of the total rural mileage, about one-half of the total rural highway expenditures are made.

It is, therefore, obvious that to the extent that cities are successful in taking away funds which would ordinarily be spent on rural highways the rural highway program is either retarded proportionately or other sources of revenue will have to be found. It is generally agreed by those who have studied the problem that rural property, real and personal, is taxed about as much in that case as that kind of property can reasonably bear. In certain states cities attempt to get additional revenues from motor vehicles by charging an annual wheelage tax or a license fee in addition to the state license fee.

Funds for Highway Traffic Control.—Highway traffic control is another purpose for which motor vehicle revenues are used. In 1928 $1,932,845, or 0.6 per cent of the license fees was charged to this account. Charges which should properly be made to this account may in certain states be concealed in other items. It's an expense which as time goes on will make its appearance in most of the states where heavy traffic conditions are apt to occur. State highway departments are beginning to feel that their task is not limited alone to construction and maintenance of highways but that the supervision, control and regulation of traffic passing over these highways is an important function of maintaining highway transportation. And its cost should logically be a charge against the operators of motor vehicles. Another growing expense in our northern states is that of the removal of snow during the winter months. This is a cost which should naturally be charged against motor vehicle users and come out of license fees and gasoline taxes.

Funds for Miscellaneous Purposes.—Of the total highway revenues 1.8 per cent or $10,825,436 is classed as miscellaneous. Some of these expenditures are directly connected with highway use and others have no direct connection. Of this total miscellaneous expenditure, $7,770,516, or 21 per cent of the gasoline taxes collected in the states of Florida, Georgia and Texas is turned over to the school funds and used for school purposes. Some of the other miscellaneous purposes are as follows: Mississippi took $215,257 of her gasoline tax revenues, which were special additional taxes in three counties, and used them to defray the costs of a sea wall for road protection; New Hampshire used $470,834 of gasoline taxes for flood damages; Montana used $33,313 of license fees as an auto theft fund; and New Jersey appropriated $300,000 of the license revenues for a state highway commission office building. In states where there is great difficulty, for some reason or other in balancing the budget there is a constant temptation on the part of legislators to use the gasoline tax as a means of raising funds for purposes other than highway. Such a policy is ordinarily to be disapproved. But certain financial conditions and taxation problems may confront state governments where it is found more feasible to turn to the gasoline tax and regard it as a general sales tax and raise funds for purposes far removed from highways and highway transportation.

Conclusion.—No one has been able to law down a policy for the distribution of motor vehicle revenues or of raising funds for rural highway purposes which has received countrywide approbation. No such formula or formulae in my opinion, can be devised. Each state is faced with a different set of conditions. It is a general axiom that the motor vehicle revenues, after collection and administration expenses are met, should be applied to highway purposes. No definite rule can be laid down as to how the distribution between state highway systems and local road systems should be made. Such matters as the state's bonding policy, pay-as-you-go principle, and other aspects of the financing of public improvements have to be taken into account and given due consideration whenever states take up this question of raising funds through motor vehicle license fees and gasoline taxes. In the long run motor vehicle operators will find that it will be to their economic benefit if extensive highway improvements are financed through motor vehicle revenues, even though that may result in an increase of license fees and gasoline taxes, rather than go without such improvements and avoid the increased payments. In the distribution of motor vehicle revenues all political phases of the matter should be waived aside and the welfare of the motorist and the general public be made the main and only consideration.

Acknowledgment.—The above paper was presented July 11 at the annual meeting of the American Society of Civil Engineers.

Construction of National Highway in Greece.—The Greek Government recently entered into a contract with the firm of Makris & Company of Athens for the construction of an extensive system of highways throughout the whole of Greece. During 1929 immediate attention will be given in this district of Saloniki to the construction of a highway from Saloniki to Xanthi, a distance of 170 kilometers, and from Kadikeuy Semenli-Orestias in Thrace, a distance of 45 kilometers. These roads will be macadamized or covered with asphalt.

[1] Report of a Survey of Transportation on the State Highways of New Hampshire by U. S. Bureau of Public Roads and the New Hampshire State Highway Department, 1927, page 7.
[2] Public Roads, June, 1927, page 62.
[3] Report of a Survey of Transportation on the State Highways of Vermont by U. S. Bureau of Public Roads and Vermont State Highway Department, 1927, pages 6, 47, 51.

Aerial Survey of Highway Traffic

How Traffic Counts Were Coordinated with Photographic Records

By A. N. JOHNSON
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ON July 4, 1927, the State Roads Commission of Maryland had an aerial traffic survey made of the road between Baltimore and Washington.

For this purpose there were engaged the services of the Chesapeake Aircraft Co., of Baltimore, who made a series of photographs taken at an altitude of about 3,600 ft. The resulting photographs were on a scale of approximately 300 ft. to the inch. These were subsequently enlarged to a scale of about 115 ft to the inch. The distance covered by the photographs, from the Baltimore City line to the District of Columbia line, was very nearly 29 miles; 127 exposures were made, so that each photograph was overlapped by the succeeding one about 50 per cent. Owing to various causes, the scale of the photographs varied somewhat, as did the amount of overlap.

The actual time elapsed during which photographs were taken was 27 minutes, or slightly less than 13 seconds between each exposure. The time of the flight was between 4:30 and 5 p. m., this hour being selected as the one most likely to show a large amount of traffic and yet with sufficient daylight to insure good photographs.

The Traffic Counts.—In addition to the photographic record thus secured, traffic counts were made at four points; one near the Baltimore City line; one at Laurel, about half way; one at College Park, a few miles from the District Line and another about one-half mile from the District of Columbia line. Between these last two counting stations the Defense Highway joins the Baltimore-Washington Road; thus, on the last two miles of the road there was the additional traffic due to that from the Defense Highway.

At each of the traffic stations there were two observers, one counting northbound and one the southbound traffic during the period from 3 to 6 o'clock. The observers at the traffic stations noted the traffic at 5-minute intervals, from which varying rates per hour were calculated.

In addition, six cars were fitted with white tops by stretching a sheet over them, and a driver and observer in each. These spot cars, as they were called, were timed to enter the traffic on the road so as to be photographed at various points. The drivers of these cars were instructed to drive with the traffic, not attempting to pass slow moving traffic, not to hold up traffic. The observers made frequent observations as to the speed of traffic, which

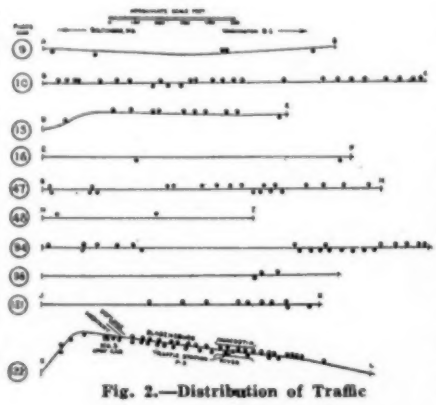

Fig. 2.—Distribution of Traffic

was from 20 to 30 miles per hour, the highest noted being 33 miles per hour.

What the Traffic Counts Showed.—In Fig. 1, the results are shown for the traffic counts made at these stations, their relative location, and the actual number of vehicles for each hour being recorded for north and south bound traffic respectively. It will be noted that hour by hour during the three hours for which the count was made, the flow of traffic was very uniform in each direction. These results are also tabulated in Table I.

While the hourly movement was nearly uniform, the variation of hourly rate for 5-minute intervals, as indicated in the last two columns of Table I, is between 500 and 1,300 for that portion of the road between Baltimore and the Defense Highway. The last one or two miles towards Washington which carried the additional traffic due to the Defense Highways, is seen to average nearly 1,400 vehicles per hour, the variation being from a little over 900 to nearly 2,000 per hour for 5-minute intervals.

From the fact that the movement of vehicles for each hour is very nearly uniform, we may with sufficient accuracy for this discussion assume that during the 27 minutes the road was being photographed as many vehicles flowed on as flowed off the road; therefore, the continuous picture made up of the aerial photographs may be taken as substantially that which would be secured were it possible to take at a single instant a photograph of the traffic of the entire road. Such a picture of the traffic was secured. To do this, the first step was to choose the portion of each photograph which was to be used. As the amount of overlap was not always uniform, it was necessary to select a longer section on some photographs than on others.

Distribution of Traffic.—From the charts, thus prepared, a graphic representation of the distribution of the traffic becomes apparent. To reduce this to a sketch that could be comprehended at a glance, a diagram was made that showed the number of vehicles in each quarter of a mile, as illustrated in Fig. 5. But a glance at this figure is sufficient to disclose how uneven was the distribution of traffic. In some quarter mile sections there is but one or even no vehicles, and nearby there may be 15 or 20 per quarter mile.

From Fig. 3 may be seen that the average number of vehicles per quarter mile is about 7. At a speed of 25 to 30 miles per hour, 7 vehicles per quarter mile would give an average flow of about 800 per hour, which was

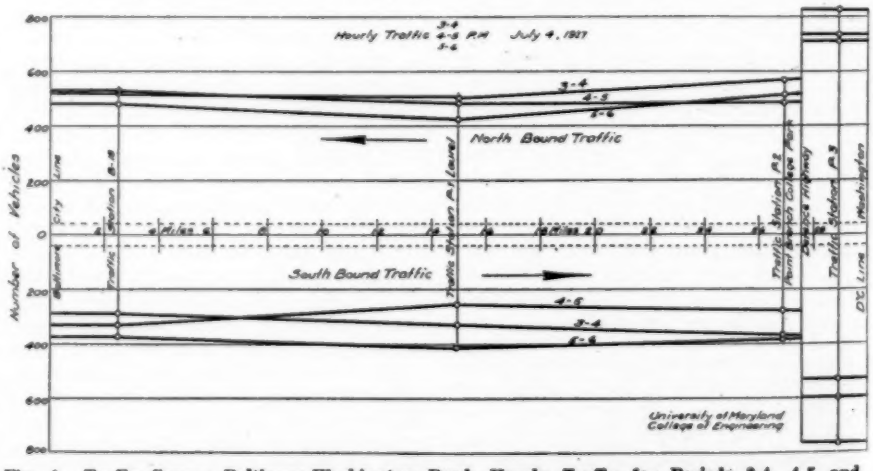

Fig. 1.—Traffic Survey Baltimore-Washington Road, Hourly Traffic for Periods 3-4, 4-5 and 5-6 P. M.

the number as shown by the actual traffic counts.

To illustrate more clearly how uneven was the distribution of the traffic, we will refer again to Fig. 2 and compare the number of vehicles shown in photograph 9 with the adjacent photograph 10, photographs 15 with 16, 47 with 48, 94 with 96, and 121 with 122, where the rate for the latter was about 40 vehicles per quarter mile.

From many observations of traffic on this particular road, it has been ascertained that a crowded condition occurs when the hourly rate over a 5-minute period lies between 800 and 1,000 vehicles, that is it begins to be inconvenient for the faster moving vehicles to overtake a slower.

The actual discharge per hour of this traffic was about 800, yet traffic so used the road as to cause serious congestion at a great many points, as may be noted from Fig. 5 which shows the frequency with which various quarter miles carried more than 7 vehicles. In fact, we find that 50 per cent of the road was crowded, that is having more than 7 vehicles per quarter mile, while about 20 per cent had from 5 to 7 vehicles, and 30 per cent 0 to 4 vehicles per quarter mile, illustrating how inefficiently the traffic made use of the roadway.

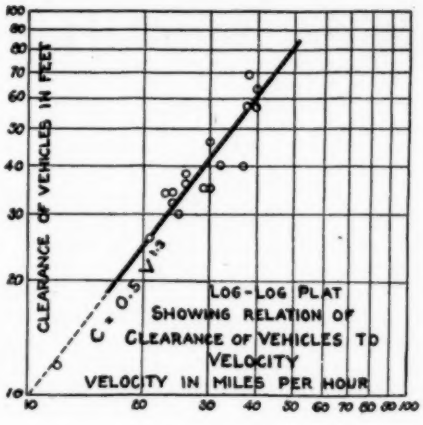

Fig 4.

Thus, a number of observations could be made showing the speed as platted against the clearance. If the time between exposures was known accurately, as well as the scale of photographs, then the elements necessary would be known accurately. The facts are that the scale of the different photographs varied somewhat, as well as the interval between exposures, and it would be expected that observations made, as here outlined, would vary somewhat.

Table I.—Traffic Counts, Baltimore-Washington Road, July 4, 1927

	3-4 p. m.	4-5	5-6	Average number vehicles per hour	Max. and Min. rate per hour based on traffic for 5-mi. intervals	
B-18 Near City Line— Baltimore	809	860	857	842	1,284	522
P-1 Laurel	835	739	826	800	1,236	504
P-2 College Park	940	769	881	863	1,188	600
P-3 near D. C. Line	1,357	1,312	1,502	1,390	1,968	912
Muirkirk	.....	736	.....	.....	.....	.....

Clearance of Vehicles.—In Fig. 4 are the results of such plats on a double log scale, and it is seen that while there is more or less variation from one observation to another, there is a very general straight line trend. From these observations it is shown that the clearance varied approximately as the 4/3 power of the velocity. The general formula for the number of vehicles passing a given point at a given velocity of V miles per hour, with an average car length of 15 ft. is

$$N = \frac{5280V}{C+15}$$

where C is the clearance between the cars. If we introduce in this formula the value for C, as here found, we have the discharge per hour of vehicles in single line as

$$N = \frac{5280V}{0.5V1.3—15}.$$

The number of vehicles that will pass at varying speeds are shown in Fig. 5 by curve A, and the maximum number 12,800 is obtained at a speed of a little less than 35 miles per hour.

The curve B shows the relationship between the discharge of vehicles and velocities on the assumption that the clearance varies as the square of the velocity. From the nature of the observations made from the photographs of the traffic, the results obtained from them are probably very much closer to actuality than the assumption made that the velocity varies as the square. Where the velocity varies as the square, it is noted that maximum discharge, about 2,600, vehicles per hour, occurs at a speed of 15 miles per hour, and that for higher speeds the curve turns down rather sharply, whereas, if we assume the clearance varied as found for curve A, the maximum is about 2,800 and the curve is more nearly flat for velocities from 20 to 50 miles per hour, that is for these velocities the number discharged per hour does not vary greatly. According to these figures then at 30 to 40 miles per hour, with vehicles going in each direction, on a two-lane road, there should be a total discharge of about 5,600 per hour. For short intervals of time, such a rate of discharge did actually occur. But so far as the writer has been able to find, there is no record of any hourly discharge of a single line of vehicles exceeding 2,000. The maximum reported for the Holland Tunnel traffic was just under this amount, about 1,900.

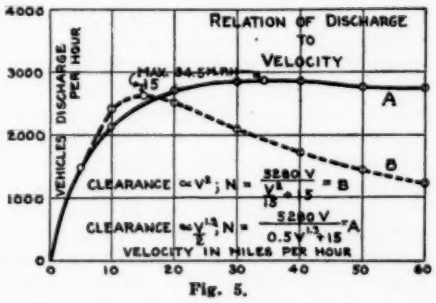

Fig. 5.

A conclusion to be drawn from the aerial traffic survey is the importance of any regulation which will tend to greater uniformity in the distribution of traffic and that whatever will help to do this will to that extent increase the efficient use of the road.

Acknowledgment.—The above is an abstract of a paper presented at the 8th annual meeting of the Highway Research Board.

In a paper by the writer presented to the American Society of Civil Engineers on Jan. 22, 1925, and printed in the Transactions, vol. 89, page 259, it was stated that from the best observations he had been able to make that the clearance of vehicles appeared to vary in the neighborhood of the square of the velocity, that is, as a line of vehicles increased their speed they increased the distance between individual cars as the square of velocity.

The aerial photographic survey of traffic affords a means of making far better observations than is possible otherwise. The fact that adjacent photographs overlap, the same group of vehicles may be found in two succeeding pictures, but displaced by the distance that they traveled between the times of the successive exposures.

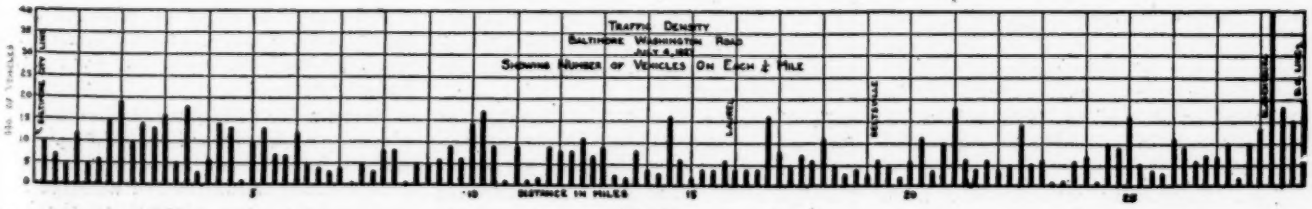

Fig 3.

Roadside Beautification

What Is Being Done in Various States

GOOD progress has been made in some states in the planting of trees, shrubbery and flowers along the state highways, while in other states very little has been accomplished in the way of roadside beautification. An interesting summary of what is being done in various states is given in a preliminary survey by the Vermont State Chamber of Commerce, of which James P. Taylor, St. Albans, Vt., is secretary. This survey, based on correspondence from state highway engineers contains the following:

Where Trees Have Been Planted:—California writes, "This phase of our work is receiving more attention each year. We consider this matter very important in California. We have some 600 miles of planted trees along the roadside, this work having been under way for a number of years." Oklahoma reports 2,000 trees planted along 40 miles of highways during 1927, and about the same number during the last year. Delaware says, "On a large per cent of these highways, trees have been planted and, in some cases, shrubbery."

In states where such results have not yet been achieved, there is the conviction that such activity is inevitable and desirable, something in which the highway department should play a part. Arkansas writes, "We believe that systematically beautifying the roadsides along high-type roads would be a worth-while investment of public funds." And Ohio declares, "I think this should be a part of the program for every state highway department, especially the planting of trees."

But more significant than these sound opinions are the vivid intentions of some to begin this work in the near future. Louisiana writes, "This matter has come up several times in this state, but we have never been able to get very far. We expect, however, to make some headway with this proposition within the next year or two." And Georgia, "It is our plan on next year's work, to take this matter into consideration and doubtless will plan to beautify our highways by planting trees or shrubbery along same." Then Nevada, "At a future date a few of the highways in the western portion will be planted with shrubs and trees."

Great interest in the development of this roadside beautification movement is expressed even by State Highway Departments which make such reports as "Nothing done and no funds," "So many miles of road to build and so little money," "No definite or organized movement."

New Hampshire writes, "We have been so busy trying to get a road system that we have paid little attention to the scars left on the landscape," but adds, "We cannot afford to let this matter get away from us."

Minnesota says, "We have barely started on a road improvement program and this has been under way only a few years," but has this comment to make on highway beautification, "It is something that will quite naturally follow the construction of highways itself."

And North Dakota: "Our population is scattered and the total funds of our state are not sufficient to warrant any right-of-way beautification for some years to come."

Work by Civic Organizations.—Florida reports, "a State-wide Beautification Club which is very active, and I believe within the next year or two a great deal will be accomplished in this line, either by the state through legislation or by this club through cooperation with local civic organizations."

And similarly Wisconsin, "There has been quite a movement on foot in this state, by an association known as the Friends of Our Native Landscape, to induce the various counties of the state to take an active part in the beautification or the saving of trees and shrubs along our highways. Quite a few counties are planting trees and have been planting trees for several years."

In Colorado the Colorado Historical Society has given attention to the task about which the state highway department writes, "With so many miles of road that need improvement we do not feel that any activities along this line you mention are warranted."

Arkansas refers to "Some work by civic organizations;" Alabama "appreciates very much indeed" the activities of women's clubs; and Arizona quotes "The Valley Beautiful Campaign" of the Phoenix Chamber of Commerce.

West Virginia, Kentucky and North Carolina cite the work here and there of local organizations, and Virginia, the garden clubs of the state.

In South Carolina the state highway commission is itself taking the initiative in the setting up of a system of beautification organizations in accordance with the following resolution, "That each member of the state highway commission is hereby requested to encourage, and wherever necessary to initiate, the establishment of a permanent highway beautification organization in his judicial district."

In Vermont the State Chamber of Commerce with the approval of the state highway department is cooperating with local Chambers of Commerce in the appointment of committees for the beautification of the highways in their several regions.

Cooperation of Highway Departments and Citizens.—There seems to be almost every possible variety of relation between the state highway departments and the citizens' organizations interested in roadside beautification. At the one extreme is the case of Arkansas where the department is not in a position to "take cognizance" of the activities of the citizens' organizations. At the other extreme is Illinois where the cooperating private organizations "work under permits granted by our department, and in conformity with the policy which we have established."

For the most part, however, the activity of the departments is that of giving "encouragement." The Indiana department "encourages local clubs, societies and organizations to take up this work, wherever they can be encouraged to do so." In Maryland the State Forestry Department, which has the matter in charge, writes, "We are also encouraging people to plant trees along the highways, wherever possible."

The state of Washington stimulates and capitalizes the interest and enthusiasm of individual citizens living along the highways through providing by law passed in 1927 that "Owners of property adjacent to the state highways may be permitted to plant lawns, trees, shrubbery, etc., on the right of way of the state highway, provided such planting does not interfere with the maintenance or construction of the highway."

So much for legal permission in the state of Washington. Protection had been insured by a law passed in 1925 as follows: "It shall be a misdeameanor to cut down, remove, destroy, or uproot any flowering or ornamental tree or shrub or any flowering plant, either perennial or annual, or any part thereof, within 300 ft. of the center line of any state or county road within the state."

How Many Miles? How Many Trees?—While in a hasty preliminary survey it is quite impossible to quote mileages and numbers systematically by states or on a national scale, the following figures indicate that the roadside beautification movement is being taken very seriously and that it is well on its way.

Six hundred miles of planted trees along the roadsides of California, this work having been under way for a number of years.

Forty miles of highways in Oklahoma planted with trees in 1927, approximately 2,000 trees having been set out.

Fifty-four thousand five hundred and eighty-eight trees planted on the bor-

ders of state highways in Massachusetts during the last 22 years.

Ten thousand small evergreen trees planted along highways in Indiana during the year 1928.

One hundred and forty thousand mixed pine seedlings planted along trunk lines in Michigan in 1928.

Beautification Organization in State Highway Departments.—Where roadside protection and beautification has been placed by law in the hands of the state highway departments, they have set up within the department organizations such as "landscape division," "forestry unit," or made a beginning through the employment of specialists who supervise the beautification activities of the employees of the state highway department, and of civic organizations of citizens which are interested to cooperate in this work.

All these are steps in a very recent development. Although Massachusetts began the work of roadside treatment in 1921 and California and Connecticut had planted trees along roadsides for several years it was not until the summer of the year 1927 that Connecticut organized her "landscape division," and that the Michigan Maintenance Department took over the task of beautifying trunk line roads, and that Oklahoma began planting trees along the highways. It was not until the year 1928 that California employed a "landscape engineer," Missouri, a "landscape architect," and Pennsylvania set about organizing her "forestry unit."

The beautification personnel and an idea of their work in some of the states are given below:

"We have recently engaged a landscape architect, primarily for the purpose of supervising the necessary planting along the shoulders and side slopes to prevent their washing.

"Through a circular letter to chambers of commerce, civic clubs, and similar organizations, the consulting services of our landscape architect have been tendered the various communities of the state."—Missouri.

"This season a landscape engineer has been employed and definite regulations governing the trimming and clearing up of our roadsides have been adopted."—California.

"This work is carried on by the maintenance field organization and under the supervision of a trained forester in the residency or at the Lansing office."—Michigan.

"An experienced forester is in charge of the work. He will be assisted by eight division foresters, who will supervise the work in the various highway districts. The maintenance crews will carry out the work of beautifying and protecting the roadside under the supervision of the division foresters."—Pennsylvania.

"The state has a nursery at Palmer, Mass., where trees and shrubs are propagated and where the highway landscape supervisor trains men in the care of trees and roadside beautification. This nursery is a part of the maintenance division."—Massachusetts.

"During the past 11 months (August, 1928) the landscape division has had 10 landscape gangs at work throughout the state, trimming trees and cutting brush along scenic routes to open up vistas hitherto closed to the passerby.

"In securing men for these groups we endeavor to get into each group two or three young men who have had a training as tree specialists and two or three who have had landscape training and are used to planting and maintenance of young trees and shrubbery. We also utilize some of the gangs of the division of maintenance and repair for rough work, such as grading and clean-up work at times when they can be spared from their regular maintenance duties."—Connecticut.

The A B C's of Roadside Beautification.—Even in states which have as yet no organization set-up for roadside beautification the perfecting of highway maintenance proves to be the beginning of roadside beautification, for the usual maintenance operations usually include such items as the following, which certainly constitute the A B C's of beautification:

"We are making an effort to grass and sod all of the shoulders of our state highways and we feel that this will help the appearance of the same, as well as reduce maintenance costs."—North Carolina.

"Planting of trees, shrubs and vines on all slopes, whether cut or fill, to protect same against wash and erosion."—Indiana.

"No beautifying of the roadsides with the exception of the cutting of the grass and weeds and keeping the roadside in as presentable a condition as is consistent with the amount of money we have to spend."—New York.

"Replacing, two for one, all trees which it is necessary to remove in connection with the improvement or reconstruction of state highways."—New Jersey.

"No particular effort along the line of beautifying roadsides other than the complete removal of all advertising signs on state highway rights of way."—Wyoming.

"Nothing done in regard to beautifying roadsides, except a law has been passed by the legislature prohibiting the placing of signs on any right of way of any road included in the general plan of the state."—Tennessee.

"About all we can do is to discourage unattractive advertising signs along the roads."—South Dakota.

"No policies for beautifying roadsides. However, we are trying to regulate billboards and advertising signs along the highways."—Arkansas.

"Under an order issued by the highway department practically all signs have been removed from the right of way of state highways in Arizona."—Arizona.

Other Beautification Activities.—A composite picture of the other beautification activities of state highway departments and of citizens' organizations proves to be a very elaborate affair with many features, which may be sketched as follows:

"We are at the present time securing wide right of way and very few of the new highways are being constructed on right of way widths under 100 ft. In the future, if funds will be available for roadside beautification, this additional width will, no doubt, be quite an advantage."—Minnesota.

"We have adopted a policy of replacing trees, which we of necessity have to cut down in construction, with young trees where it is advisable and when the owners of property adjacent to the road are willing to have the trees placed on their property far enough away from the road metal to allow for future widening of the pavement."—Rhode Island.

"The removal of dead branches and dead trees; first aid to injured trees through sealing wounds with tar and fastening split trees with bolts; care of trees by pruning and shaping."—Massachusetts.

"Encouragement of growth of native wild grasses and ferns and flowers through cleaning roadsides of rank growth and unsightly brush."—Connecticut.

"The object is to keep the roadside as natural as possible by the use of native material. Importations may be attractive, but they do not reflect the personality of the state. The men engaged in this work are advised to study how nature plants and imitate it as far as possible."—Massachusetts.

"Young shade trees are being planted on newly constructed routes and there has already been considerable roadside planting of shrubbery on new rights of way where there is no native growth.

"Special attention is being given to the slopes along our newly constructed roads, and their seeding or planting as soon as possible after the construction work is completed."

"In some cases where slopes are too high and too steep to be seeded to grass, vines are being planted, rambler roses having been used in various parts of the state. Slopes in Norfolk were planted with rambler roses last fall and woodbine, honeysuckle and other vines, which beautify the slopes and protect them from washing down into the road are often used."

"Transplanting of native growth, such as pine, hemlock, gray birch and laurel has been carried out extensively this spring, to beautify wild scenic spots where there has been road construction."—Connecticut.

"Plantings on roadsides are mainly confined to new construction for several reasons. The wider locations (60 ft. or more) give more opportunity for scenic development, and these relocated and widened roads promise a fairly undisturbed future. Monotony of straight

lines and even spacing is avoided. Grouping of trees and shrubs is at all times preferable."—Massachusetts.

"The task of planting barren areas for permanent snow protection was started last spring when 140,000 mixed pine seedlings were planted in the eastern half of the Upper Peninsula along trunk lines. This type of work has merely begun and the plans for future planting are very extensive and will include all areas in Michigan."—Michigan.

"Scenic spots along our highways are being developed. These places are being established near water, a brook, lake or a spring and at all of them sufficient area is arranged for parking of a few cars off the traveled path of the highway. On the Middletown-Saybrook road a rock garden has been made on the west side of the road and on the east side a small highway park and rest place, to be known as "Seven Falls."—Connecticut.

"Roadside springs are being made available to travelers. Benches are provided in suitable places."—Massachusetts.

"The Highway Commission has acquired property on which there is good water supply for drinking purposes. Some of these are in timbered regions, others in desert regions. Water rights have been secured to protect the supply for the general use of public."—Oregon.

"A number of highway intersections throughout the state have been planted."—Michigan.

"Small highway parks at road intersections and at points adjacent to abandoned sections of the highway."—Connecticut.

"These little pieces of land, sometimes amounting to a mere fraction of an acre and sometimes amounting to one or more acres, are irregularly shaped and would be of little value for agricultural purposes. We are holding on to all these pieces of land and expect some day to develop them into little parklets where the road user can get off the traveled portion of the highway and not be a trespasser. As yet we have made no tangible effort in the improvement of these little parklets, but hope to develop them some time in the future."—Iowa.

"Since the introduction of high speeds in motor vehicles intersections have been made less hazardous by big easy curves, with the result that triangular strips of ground have been left between the original right angle intersections and the easement of wyes built. These in most instances, have been cleared up, graded and planted by the counties themselves. In this way there is a small amount of beautification work being done."—Wisconsin.

"At important intersections in built-up communities where traffic circles and grade separations are being installed, the slopes and areas within the traffic circles are being landscaped and made as attractive as is possible with a reasonable expenditure."—New Jersey.

"The State Highway Commission has acquired quite a number of desirable sites varying in size from a fraction of an acre to several hundred acres. In the Blue Mountains in eastern Oregon the highway commission is acquiring at the present time a strip of land approximately 1,000 ft. in width, being 500 ft. on each side of the highway. This strip contains some valuable standing timber, which it seemed desirable to acquire at this time in order to prevent it from being logged off."—Oregon.

"Considerable work has been done in the Upper Peninsula toward conservation of virgin timber from beautification and snow protection standpoint. To date $48,000 has been spent in the purchase of 400-ft. strips of virgin timber and deals amounting to $50,000 are pending."—Michigan.

"We are attempting to install a system of roadside highway parks. This department is advocating legislation for permission for the Department of Public Works to secure points of scenic and historic interest adjacent to the highways, and make them a part of a statewide park system."—Idaho.

"Frequently in excavating for bridges or making investigations, we find evidences of prehistoric ruins. These are regarded as of archaeological interest and endeavor is always made to spare them for this reason, even if it necessitates relocating a bridge or highway."—New Mexico.

"The Forestry Unit of this department will open views that desirable vistas may be gotten from the roadside."—Pennsylvania.

"Our beautification program will include the removal of undergrowth from hill tops to afford view of the surrounding country."—Missouri.

"Vistas of mountains, lakes and streams are developed by removal of foliage screens."—Massachusetts.

Nation's Need for Highway Development

"The manufacturing of good roads differs little in basic principles from any private manufacturing enterprise," declares Charles M. Upham, director of the American Road Builders' Association, who has just returned from speaking on this subject in Cleveland, Chicago and other western cities.

"The wise expenditure of public funds depends entirely on whether these principles are followed or ignored," he adds. "It has been proven beyond question in many states that huge sums may be expended for highways, under business management, without waste, the investment bringing highly satisfactory returns in decreased transportation costs and generally increased prosperity. The expansion of this condition, country-wide, can best be accomplished by distribution of highway educational information. Without this knowledge, funds are wasted, expansion is restricted and highway industrial stagnation ensues."

The needs of the nation for highway development, Upham finds, call for greater activity in the industry and unceasing educational effort to awaken the people to highway needs and highway possibilities.

Among the needs cited are: high speed by-pass arteries around large population centers; grade separations at intersections; elimination of "bottle necks"; addition of more exit and entrance roads to cities: widening programs, to a minimum 40 ft. width in the vicinity of large cities; financing and development of the rural highways and "farm to market" roads; greater use of highway bonds for financing state and county road building programs.

"County highway construction, finance and administration presents a broad field for study and investigation," he declares. "Until the problems confronting many counties are solved by application of educational information, funds for highway improvement will be lacking and the neglected and much needed farm to market roads will be slow in materializing.

"There are 3,000,000 miles of rural highways in this country, 600,000 miles of which are improved to some extent. Less than half of this mileage is paved. This, in conjunction with 150,000 miles unimproved of the total 300,000 miles on the state systems presents a huge program for the road builder.

"Looking at the gas tax situation from the standpoint of car upkeep and per capita share of highway costs, the expense even at the maximum rate constitutes a very low road toll. The car owners in the 2 ct. tax states, based on tax income and the number of registered cars, pay $9.63 average annual tax; the 3 ct. group pays $13.85; the 4 ct. group pays $21.34; and the 5 ct. group pays $22.43. The average for all is $15.09 per car owner per year. Most opposition to this form of road toll has developed in localities where the tax has been used for other than highway purposes.

"The toll amounts, at most, to about ⅓ ct. per mile on the car which gets 15 miles to the gallon of gasoline and pays 5 ct. for gas tax. Where the tax is lower, or the car mileage per gallon higher, the toll is correspondingly lower. In any case the toll is easily absorbed in lessened cost of upkeep of a car which is driven over improved roads.

"The highway constructed today is better and cheaper than that of a few years ago. Increased production and research have brought good results and this is only the beginning. That greater activity in highway research would react beneficially is unquestioned."

Highway Construction in Saskatchewan

Practice in a Western Province of Canada

By H. ROSS MacKENZIE

Chief Field Engineer, Department of Highways, Province of Saskatchewan

OUR provincial highway system comprises 7,300 miles, and the Department of Highways has assumed the responsibility of constructing and maintaining our provincial highways without requiring any direct financial assistance from our rural or urban municipalities.

The population of Saskatchewan is approximately 900,000 and the present relation of population to road mileage makes it impossible for us to finance the construction of any material mileage of hard surfaced roads in the rural districts, consequently for the present at least we are forced to confine our attention to earth and gravel roads.

During the past eight years we have constructed, under engineering supervision, approximately 3,300 miles of high-standard earth road on our provincial highway system. We are steadily raising our standard, and find it necessary to revise our specifications annually in order to eliminate as many as possible of the difficulties encountered in maintaining roads built to our obsolete standards, and in order that we may provide for the requirements of an ever-increasing volume of motor traffic, travelling at increased speed.

It is extremely difficult to anticipate future traffic requirements, but we are endeavoring to so locate and construct our earth roads that they will have to be altered as little as possible when constructing the higher-type road that the future will demand.

Highway Location.—Saskatchewan is a part of the great central plain, and many people resident in Canada, and even some resident in Saskatchewan, assume that it is treeless and almost perfectly level, and that consequently there are no topographical difficulties to be surmounted when constructing roads or railways. On the contrary, Saskatchewan has unusually abrupt changes in elevation, noted examples being the tributary valley of the North and South Saskatchewan, Qu'Appelle and Frenchman rivers. These valleys drop 300 to 400 ft. below the prairie level in a distance of ½ to ¾ of a mile, and all our north and south highways have to cross at least one of these valleys. In locating roads on provincial highways, we have adopted 7 per cent as the maximum gradient.

Alignment. — In Western Canada there was no particular development in highway construction until after the advent of motor cars. Consequently our roads have, in the first instances, been located to serve motor traffic, and in this respect we have a decided advantage over some of the older provinces in Canada, where expensive widening and relocating of highways were necessary to meet the changed traffic conditions. Even a typical Westerner is not sufficiently optimistic to assume that we are able to accurately estimate the traffic requirements of the future, but we are placing a great deal of emphasis on good alignment and adequate sight line. We provide for a clear sight line of 500 ft. on both vertical and horizontal curves, and we have adopted a 16-deg. curve as the sharpest curve to be used on our provincial highways, and this maximum curve is now being constructed at all right-angled turns. On all other road diversions, the maximum degree of curvature is avoided wherever feasible; most of our curves are from 5 to 8 deg.

Grade Crossing Elimination.—We are changing the route of many of our highways in order to eliminate grade railway crossings. We are improving the sight line and placing stop signs at particularly dangerous crossings which cannot be avoided. Where the general direction of the highway is parallel to the railway, we construct "balloon" curves in order that the driver of a motor car may be able to see trains approaching the crossing from either direction.

Diagonal Roads.—Our road allowances are laid out on the rectangular system, and another feature of our location work is the securing of diagonal roads in order to reduce distances between important points. A reduction in distance is important from the standpoint of construction and maintenance, as well as operating costs. Prof. T. R. Agg, of Iowa State College, has estimated that for a road carrying 1,000 cars per day, an expenditure of $316,000 would be justified to shorten the road by one mile. In the case of the highway from Esteven to Moose Jaw, the distance, following surveyed road allowances, was approximately 190 miles, but this distance is being reduced to approximately 145 miles by building a diagonal highway along the railway right-of-way.

The feasibility of building a highway parallel to a railway right-of-way in some districts of our province is quite apparent when I tell you that we have a railway line running southeast from Regina for a distance of 90 miles without a single curve.

The securing of additional width of right-of-way is the latest development in our location work. We have found that a 66-ft. right-of-way is inadequate for a road that is destined to become a heavy traffic route, and on our most important roads we are now securing a 100-ft. right-of-way.

Width.—We are using a crown width of 24 ft. on our important highways. I know that there is a theory that the width of a road should be a multiple of the width required for one line of traffic, namely, a multiple of 10 ft.; we are told that a 24-ft. road, for example, has the same capacity as a 20-ft. road, because they are both two-lane traffic routes, but a 24-ft. road has an additional factor of safety, particularly on an earth road, which, unfortunately is not of the "non-skid" type. And a 24-ft. surface permits gravel to be windrowed on the shoulder without seriously affecting the serviceability of the road.

Grading.—On certain prairie sections of Saskatchewan, a difficulty unknown in Eastern Canada is found in the drifting of summer-fallowed land. Intense cultivation pulverizes certain types of soil, and in the absence of wind breaks, this pulverized soil drifts badly. Side ditches and off-take drains adjacent to summer-fallowed fields are often obliterated, consequently the road surface in these sections must be kept well above the prairie level if the road is to be maintainable. Many of our roads have 12,000 to 15,000 cu. yd. per mile, but the average yarding per mile is approximately 8,000. Some of our most expensive roads are on level prairie sections, where the natural drainage is faulty. The average cost per mile for our earth roads is approximately $3,000.

Drainage.—The lack of natural drainage channels in some prairie sections, retards the run-off; and the extreme flood conditions, due to the large area of the catchment basins of our streams, in other sections, are features that affect the design of our roads. We have to provide many small bridges which operate only for a few days in the year, and in some cases the bridge contractors actually had to haul water for concrete mixing, when building 60-ft. or 80-ft. bridges.

We have approximately 3,000 bridges on our highways with spans of 20 ft. or over, the total length of these bridges being approximately 24 miles. We have 45 free government ferries operating on our larger rivers as sub-

stitutes for bridges which would cost approximately one-half million dollars each.

For small culverts we use corrugated iron, concrete and treated timber. Pipe culverts less than 18 in. in diameter are not used under the roadway.

Slopes.—The width of the road surface on our highways is the actual width of the embankment, consequently we endeavor to protect traffic by providing 3 to 1 slopes on all embankments not protected by guard-rail. Where the embankment is low, the easy slopes in our side ditches make it possible for cars to leave the roadway at any reasonable speed without undue danger. There is running water in many of your side ditches, but our side ditches are dry most of the time.

Gravel and Oil-Gravel Roads.—Last summer we constructed approximately 350 miles of gravel-surfaced roads. All the gravel must pass through a 1-in. circular screen, and we are using from 1,000 to 1,300 cu. yd. per mile. The gravel is placed in a windrow on the shoulder of the road and spread by patrolmen as required. The cost of the first coat of gravel surface is approximately $2,000 per mile.

Gumbo roads are the real outlaws, so far as Saskatchewan is concerned. They are difficult to maintain in dry weather, almost impassable in wet weather, and will not support a gravel surface. In an effort to keep the gravel from sinking into the sub-grade, we are now endeavoring to waterproof the surface of the subgrade before applying the gravel. This method of treating heavy clay roads has been used rather extensively in Minnesota and adjoining mid-western states during the past three years, but I believe that last summer we constructed near Regina the first road of this type ever built in Canada.

The road oil used for this treatment was obtained from crude oil by direct distillation. The specifications for the oil are as follows:

Asphalt of 100 penetration	60-70%
Specific viscosity at 60 deg. C.	10-25
Ductility of residue, not less	50 cm.
Specific gravity, 25 deg. C./25 deg. C., not less than	0.975
Total bitumen soluble in carbon disulphide, not less than	99.5%
Total bitumen insoluble in 86 deg. B. naphtha, not less than	9.0%
Flash point, not less than	90 deg. C.
Loss at 163 deg. C., 50 gms., 5 hrs., not more than	6.0%

The road surface to be treated is first compacted by traffic and then subjected to intensive blading in order to develop a smooth surface. While this operation is in progress, gravel is windrowed along the shoulders of the road at the rate of approximately 60 cu. yd. per mile.

When the road surface is smooth and dry, it is given a prime coat of ½ gal. per square yard. The oil is applied with a power distributor at a temperature of 175 to 200 deg. F., and this prime coat of oil is allowed to soak into the subgrade. After the entire roadway has received the prime coat, a seal coat of approximately ½ gal. per square yard is applied, starting on the side of the road adjacent to the windrow of gravel; and as soon as possible after the seal coat is applied, the gravel is spread over the oiled surface by means of a power grader equipped with rubber tires. The entire surface is treated in this manner and the road is then opened.

Maintenance, which consists of blading and planing, is started at once, and a thin layer of gravel is kept floating over the surface.

The second-year treatment on this type of road consists of a further application of one-third gallon per square yard, and an additional coating of 200 to 300 cu. yd. of gravel per mile.

We constructed about 20 miles of this type of road last September, and it is carrying a traffic of approximately 1,000 vehicles per day very satisfactorily. Its real test will be during the spring break-up, but I am confident that this treatment will be successful, and we propose to build a considerable mileage of this type of road next season. The cost of treatment, including the cost of the gravel, was approximately $4,000 per mile, but this cost can be materially reduced in future, as a result of our experience on this type of construction. The finished road has excellent riding qualities, is comparatively free from dust, and can be built up year after year to withstand extremely heavy traffic.

Railings and Signs.—In the matter of safety and service, we have made further advances by the adoption of cable guard-railing instead of the dangerous and ineffective wooden guard-rail, which was designed for horse-drawn traffic. We are using one ¾-in. steel cable, supported on 6-in.-diameter cedar posts, at an elevation of 2 ft. above the level of the roadway. The cable guard-rail is much cheaper to construct, and cheaper to maintain, than the woven-wire type.

The western provinces have recently adopted the route-number system of marking highways, and this system has proved to be infinitely superior to the color system formerly used in these provinces.

The real difficulties in maintenance work are to secure the necessary funds and the proper personnel. The job is not particularly difficult, but it is everlasting and requires painstaking attention and thorough supervision. On our earth roads we use a team patrol on sections of from 4 to 6 miles in length, and on our gravel roads we are arranging to use power patrols on 15 to 20-mile sections.

We have not to date undertaken snow-removal work, but this service will soon be demanded. Our snowfall is light, and our roads are open for traffic during the greater part of an average winter, without systematic maintenance. By avoiding widening or day-lighting cuts, by taking into consideration the direction of the prevailing wind when locating our roads, by keeping the surface of the road well above ground level, by the erection of snow fences, and by the removal of weeds and brush from the right-of-way, we are endeavoring to meet the demand for all-season roads.

Saskatchewan is just commencing to undertake highway improvement work on an extensive scale. Last season we constructed 475 miles of high-standard earth road and placed gravel surfacing on 350 miles. Next season we expect to build a larger mileage of subgrade and to speed up very materially on our gravel-surfacing program in an effort to meet the insistent demand for all-weather roads. Our province is enjoying a period of unequalled prosperity, and in the near future we hope that Saskatchewan may be noted for its good roads as well as for its No. 1 wheat.

Acknowledgment.—The above is an abstract of a paper presented at the 1929 convention of the Ontario Good Roads Association.

The Bewildered Motorist

As a means of the need for uniformity of traffic regulations, A. B. Barber, manager of the Transportation Department of the Chamber of Commerce of the United States and Director of the National Conference on Street and Highway Safety, points out one of the many difficulties encountered by the motorist driving from Washington to New York.

"Let me refer," he says, "to the method of making a left turn. Consider the case of a Washington motorist driving to New York. To make a left turn at an officered corner in Washington he was used to pulling into the intersection on the extreme right on the 'Go' signal, and waiting for the change of signal. At Baltimore he came to grief for failing to be in proper position to make the turn from alongside the center line of the street. On Broad Street, Philadelphia, after some difficulties he finally discovered that to make a left turn one should draw up to the right-hand curb, stop before reaching the intersection and turn on the red light. Coming to New York he found still another different system, the details of which he never did fathom.

"This is but one of the features in which the laws and city ordinances in the northeastern states are so various and divergent that it is customary for traffic officers to regard foreign plates on a car as an excuse for permitting violation of many of the driving rules. Unfortunately such an excuse will not serve to repair the loss of life or damage done as a result of conflicting traffic rules in different jurisdictions and the resulting confusion and uncertainty in the mind of the average motorist."

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The Great Risk of Air Travel

When "the great air liner City of Ottawa" fell into the English Channel, June 17, seven of its 11 passengers were drowned. Only a few days previously its owners, the Imperial Airways, Ltd., had been congratulated by Minister Thomson "on the fact that they had not lost a single passenger in almost five years." After this tragedy the owners announced that they "have flown on regular service for 3,800,000 miles and carried 99,000 passengers since its beginning in 1925 without a single fatal accident." All of which sounds quite reassuring as to the comparative safety of air travel until you do a little calculating, and then it develops that travel by airplane is fully 146 times as risky as by automobile, and 5,000 times as hazardous as train travel.

We recently published the total consumption of gasoline by American automobiles last year, and the number of automobiles, from which it was calculated that American automobiles traveled about 160,000,000,000 miles in 1928. Since about 8,000 passengers and drivers were killed in 1928, this means one killed per 20,000,000 car-miles. But the seven deaths in the fall of the City of Ottawa when divided into 3,800,000 plane-miles is one killed per 540,000 plane-miles. This is 37 times as great a fatality ratio on the vehicle basis as in automobile travel.

Now let us consider American commercial flying. There were 368 deaths in 1928, according to government statistics on Class A injuries. During 1928 the Department of Commerce has estimated that approximately 10,500,000 plane-miles were flown over the national airways on regular schedule in the United States and 60,000,000 additional plane-miles were flown in miscellaneous operation. In the same period they estimate that approximately 35,000 passengers were carried by scheduled operators. Dividing 368 into 70,500,000 gives one death per 192,000 plane-miles. Comparing this with automobile travel we find that American airplane risks have been 100 times greater than travel by car.

Considering this condition from the passenger's point of view we find from the Bureau of Public Roads that the average number of persons riding in automobiles is 2.8, from various traffic studies. This makes 20,000,000×2.8 equals 56,000,000 passenger-miles of automobile travel per fatality.

Using a high, estimated average figure of two persons per plane gives 384,000 passenger-miles per fatality for airplane travel. From Interstate Commerce Commission statistics it is determined that on American railroads there is one death per 1,971,133,000 passenger-miles.

Since the passenger is interested in his personal risk it is calculated from the above figures that airway travel is 146 times as risky as automobile travel and 5,120 times as risky as train travel. It will be noted here that if the Imperial Airways' record had been taken as a basis of comparison instead of average American flying that the passengers' chances for life, limb and the pursuit of happiness would be considerably curtailed. Yet this relates to an airplane line noted for its excellent record.

Will Rogers typifies the average man in his apparent inability to reason by the aid of statistics. Several times recently he has bewailed the tendency of newspapers to give considerable space to airplane fatalities; and has innocently asked why they do not headline the scores of fatalities that automobiling causes every Sunday. We realize, of course, that Will Rogers is a comedian, which perhaps justifies him in his statements. All sense of statistical proportion is absent in anyone who reasons that way. Statistical evidence has been accumulating that airplane travel, even in the best planes and with the most skilled pilots, is fully 100 times as dangerous to life as motor car travel.

No good can come of trying to conceal the fact. On the contrary, the more widely such knowledge is disseminated the sooner will mechanical genius reduce the hazards of air travel. The Bureau of Aeronautics is on the right track in the collection of pertinent data and statistics, but the people at large are not well enough apprised as to the results.

Misnamed "Ethical Codes"

Several of the professions have adopted "ethical codes" in which minimum fees are specified. If a labor union adopts a rule as to minimum wages, it is not called an ethical rule, nor is there any more justification for regarding a doctor's or an architect's charges for services an ethical matter. It is economics pure and simple. Then why the camouflage? Well, perhaps because it is camouflage, but perhaps because consideration has not been given to the meanings of the words ethics and economics.

At the 1928 convention of the American Medical Association the delegates voted in favor of the following insertion in the ethical code: "The practice of medicine is not the proper function of corporations, and the American Medical Association should use its utmost endeavors to stop this growing abuse." Corporations are usually not ethical organizations. Medical associations never are; their prime functions are educational and economic. They undertake to enlighten their members and to make the practice of medicine more profitable. These two functions are quite distinct, and neither of them is ethical.

If medical corporations give service that is at least equal to that given by doctors in private practice, and charge less for the service, they will survive and multiply, for that has been the history of corporations in other fields. No appeal to ethical principles will prevail, for it is not an ethical matter.

From immemorial time advertising by doctors has

been denounced as unethical. Just when does any practice become unethical? When and only when it injures a fellow being. False statements in an advertisement are clearly unethical; true statements are not unethical. Hence to brand all medical advertising as being unethical is a lie, and since broadcast lies are invariably injurious to some one, the prohibition of all medical advertising is itself an unethical practice.

Suppose that a highly successful surgical specialist were to publish his actual hospital record, and contrast it with the average record of all surgeons operating in the same hospital on similar cases; would that be unethical? Yes, according to the code of medical "ethics." No, according to any real code of ethics. Would such an advertisement injure his fellow men? Quite the contrary, for it would guide some of them to a surgeon more skilled than the average. And were he the possessor of the best record over a long term of years, it would serve admirably in showing to the public the most trustworthy specialist in a given class of surgery in their city.

However, were such advertising countenanced by the medical profession, it would speedily result in eliminating a large number of practitioners entirely, and this, we suspect, is one of the reasons why the medical "code of ethics" forbids advertising. The medical and surgical "dubs" far outnumber the really skilled members of the profession, and may be counted upon to vote down any resolution favoring medical advertising even where the advertisements are true.

Space, Time and Number

Of the debates that have gone on endlessly among philosophers, the majority relate to what seem to be our simplest and certainly our commonest concepts. What is the nature of time? of space? of number? of abstractions generally? The inability to arrive at conclusions acceptable to all thinkers, indicates either that men have reached the limits of their thinking capacity or that they have pushed their speculations beyond the known facts and are guessing. Since the latter hypothesis has hitherto been found correct in many instances it forms at least a plausible one to adopt in all cases.

Until very recently it was generally supposed by philosophers that time and space are existences apart from matter. That doctrine is now waning, if indeed it has not almost ceased to find supporters. Since neither time nor space is measurable without the aid of matter, and since both time and space are at least useless until measured, it has gradually become apparent that they are inconceivable apart from matter. If asked to conceive distance, you are forced to picture it as some measurable space, and when you conceive any unit of measure you inevitably conceive it as something material. As a matter of fact, every abstract conception is abstract only in the sense that while it is not confined to any particular thing, it must apply to some thing. This is readily seen to be true of one of the most abstract of all our conceptions, namely number. Every known class of thing is numerable, and it is merely that fact that gives to number its high degree of abstractness. But the instant you try to conceive number you must fill in the blank that is tacity assumed to follow every pure number. Five by itself is inconceivable; five marbles, five fingers, five dots are conceivable; and it is by aid of some such concreteness that number is ever conceived.

But the question may be asked why there is any need of trying to conceive an abstraction apart from matter. Do we not reason successfully about inconceivables? This, again, is an ancient subject of philosophical debate. It is noteworthy that the debaters have almost always failed to define what they mean by conception, when discussing alleged inconceivables. It is also noteworthy that their illustrations of inconceivables have almost always been taken from the realm of numbers. They tell you that very great numbers are inconceivable, but they fail to tell you what they mean by conception. The ordinary idea of conception is an instantaneous mental picture; and if this be accepted as correct, not only is no great number conceivable, but relatively small numbers are also inconceivable. Try to frame an instantaneous and distinct mental picture of 78 marbles, for example, and observe the blur that results. On the other hand, if conception be regarded as a mental picture not necessarily "instantaneous" but often a "moving picture" that requires considerable time for its formation in the mind, then you will find it possible to conceive any number, however great; for you have but to start with a very small number and multiply it by small numbers, every step of which you conceive, to bring you to the biggest of numbers.

The statement that geometrically defined lines and surfaces are inconceivable is true; but we never do any reasoning about lines that have no breadth and thickness, nor about surfaces of nil thickness. In short, we ignore the definitions and give some thickness and some breadth, however minute, to these geometrical elements. Newton really abandoned Euclid's ancient definitions when he conceived lines and surfaces of "infinitesimal" thickness. His "infinitesimals" are not nils, for adding them together (= integrating) results in "finites."

Time and space are abstractions that relate to matter in motion. Time is clearly so, for we measure it as a series of rhymical or cyclic motions! Space is not quite so clearly an abstraction of motion, but it is clearly not measurable except by something in motion or that has been moved for the purpose of measurement, whether it be the surveyor's tape or the physicists' wave of light. We know that the surveyor's tape, like all solids, is a cohesive group of electrons, and that they are in motion. Could we count the orbital revolutions of one of them we would be measuring time; and could we count a continuous series of such orbits we would be measuring space.

It is a very ancient practice to speak of distances in terms of time required to traverse them. The astronomer in stating the distance to a star in "light-years" is doing precisely what his prehistoric ancestor did when he stated the distance to a far river by giving the number of "day's walk" required to reach it. Time and space are always associated in nature, but we may measure them separately. However, the act of separate measurement does not give them separate existence. And number is equally inseparable from things. So these three fundamental abstractions, space, time and number, never exist apart from matter (including ether as matter) and always exist together in every sort and condition of matter with which science deals.

W. P. Gillette

Orton Model "A" Truck Cranes Improved

Since the time when the first Orton truck-cranes were placed in service there have been a number of developments and refinements in design and construction which add materially to the range of usefulness, the quality of performance, the ease of operation and to the length of service afforded by truck cranes, thus making them even more profitable investments for the owner.

These improvements are incorporated in Model "A" machines and are the result of over a quarter century of experience in the development and manufacture of material-handling equipment.

Chief among the improvements is the additional capacity that is provided. The Model "A" is equipped with a 55-hp. heavy-duty gasoline engine, and this power coupled with balanced design and construction gives a lifting capacity of 15,700 lb. at a 10-ft. radius and 12,000 lb. at a 12-ft. radius.

In the design of the Model "A" truck-crane special attention was given to the distribution of weight on the turntable. A large proportion of the operating mechanism, including the engine, is positioned back of the pivot post, its mass serving as part of the counterweight and eliminating unnecessary dead weight. The boom is of the lattice type and is electric welded to provide minimum weight with maximum strength and rigidity.

The turntable can be rotated at a speed of 6 revolutions per minute.

Hoisting speeds are 160 ft. per minute with a single line and load of 7,000 lb., and 80 ft. per minute with a two-part line and load of 14,000 lb.

The operator's position is in a cab extension where he has a clear view of the work on both sides of the machine.

The operating levers for the main hoist, auxiliary hoist and the swing are banked in front of the operator's position, and control each of these functions by means of clutches of the radial-thrust "V" type.

These clutches are positive in action and sensitive. The throw of the levers is relatively short.

All gears are made of special heat-treated alloy steel and have extra wide teeth. Spur gears are cut, and pinions are cut from solid blanks. Power shafts also are made of alloy steel and are ground to size. Interchangeable phosphor-bronze bushings are provided for all main bearings. Clutches are equipped with renewable blocks made of Orcoin, a composition which resists wear and withstands the action of heat and moisture.

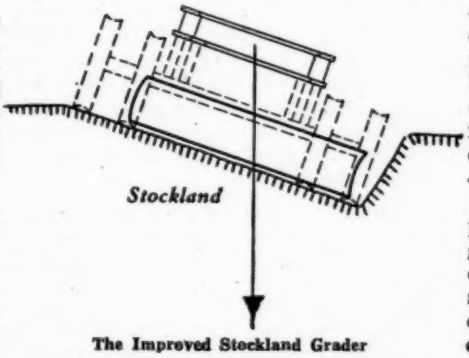
Electric welding is used liberally to reinforce the base, the turntable and the mountings for the operating mechanism, thus insuring sturdy construction and permanent alignment of the working parts.

The Model "A" truck-crane can be mounted on any standard 5 or 7½-ton auto-truck having a clearance of 9 ft. from the center of the rear axle to the back of the driver's seat. Each machine is furnished with a structural-steel base which can be bolted directly to the chassis of the truck.

A used truck makes an ideal mounting, the amount of traveling done by a truck-crane averaging approximately 10 per cent of that in ordinary truck service.

Stockland Improves Grader

One of the design features of the Stockland road grader is its low center of gravity with plenty of blade clearance. This, the manufacturer states, is



The Improved Stockland Grader

strictly a Stockland feature which has been carefully worked out by the engineers who are constantly working to give the users of road graders efficient equipment.

Because of this low design, it might appear that there would not be enough blade clearance. It is claimed, however, that all Stockland graders have a blade clearance equal to graders built higher from the ground, and yet have all the advantages of a low center of gravity design. The circle assembly can be raised the full height of the frame if necessary.

The center of gravity comes directly through and very close to the center of the cutting blade when on a 2 to 1 slope. As the design of a grader is made higher, the perpendicular line drawn from the center of the grader frame down through the blade will come correspondingly closer to the outside edge of the blade instead of the center when on a slope.

Some of the other design features claimed for the Stockland grader are the cut-lift-roll curved blade, proper location of blade, extra long wheelbase, three-point suspension, fewer working parts and heavy frame construction. All of these interesting features are dwelt upon in the new Stockland S-100 Grader Book.

Foote Bros. Gear & Machine Company, 111 N. Canal St., Chicago, Ill., who have recently taken over the Stockland Road Machinery Company, Minneapolis, Minn., will be pleased to send you one of these Grader Books upon request, without obligation.

Caterpillar Announces New Elevating Grader

The road machinery division of the Caterpillar Tractor Co. now has ready for the market the Russell Sixty elevating grader. It has a greater capacity than any other model previously put on the market by Caterpillar and is in line with that company's policies of building a better product for the consumer.

This machine is built for power take-off only and no provision for bull gear drive has been made. Elimination of the wheel drive makes the construction stronger and simpler. The Russell Sixty weighs 12,800 lb. The line shaft is 2 7/16 in. in diameter and is fitted with self-aligning roller bearings. The countershaft sprockets and wheels operate on roller bearings. Freedom from repair is further assured by bronze bushings for both upper and lower drum shafts. Convenient foot latches for all adjustment ratchets increase ease of operation. The elevator belt is 42 in. wide.

This power take-off grader will be particularly efficient in soft or loose ground, where there is usually considerable loss of power from bull wheel slippage. The Caterpillar Tractor Co. claims the Russell Sixty has greater capacity and mobility than the usual elevating grader, yet it operates with a considerable saving of fuel. It also has the proved stamina that insures its standing up and delivering day after day on the hardest jobs.

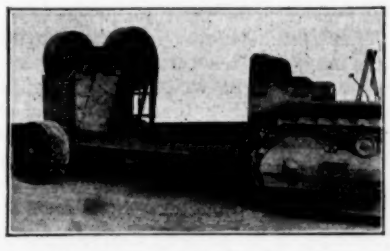
This grader has just had a successful tryout on Mississippi levee work in the buckshot soils encountered there.

Tractor Drawn Crusher Announced

The new Day Jaw Crusher, manufactured by the Day Pulverizer Co., of Knoxville, Tenn., is driven direct from a Caterpillar power take-off.

It can be attached in two minutes as the drive assembly has two universal joints and there is no delay for alignment. It is fed from the side and may be moved forward as it crushes.

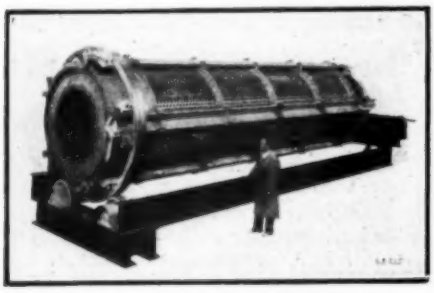
Adjustments are easily made for any size material while the machine is in operation. With its short turning radius, simplicity and ruggedness of construction, it provides to counties and various others a most economical machine as it provides crushed materials right on the job.



New Day Portable Jaw Crusher

All Roller Bearing Screens

In the new plant of the Van Camp Sand & Gravel Co. at Lebanon, O., every piece of machinery will be equipped with antifriction bearings. One of the screens, a 72-in. Telsmith-Hercules, built by the Smith Engineering Works of Milwaukee, Wisconsin, is



New Telsmith Roller Bearing Equipped Gravel Screen

equipped throughout with Dodge-Timken roller bearings and has a capacity of 300 cu. yd. of sand and gravel an hour. It has an extra heavy frame, all gears are enclosed and special protection is provided for the bearings.

The Van Camp plant, which is rapidly nearing completion, will have a daily capacity of 3,000 cu. yd. of washed sand and gravel. The 72-in. screen will be used as a scalper to precede two 60-in. Telsmith-Hercules washing screens, one of which will be used for classifying gravel and the other for the production of crushed stone. Arrangements are provided for diverting the flow of material from one screen to the other as may be necessary. These two 60-in. screens are also being built by the Smith Engineering Works and equipped with Dodge-Timken roller bearings.

United Tractor & Equipment Corp. Develop New Tractor

Recent announcements of the formation of the United Tractor & Equipment Corporation are given added significance by the release this week of specifications covering the United tractor which will be offered through this concern's distributing organization. The corporation itself is composed of 15 manufacturing members and 20 distributing members and will build and market a complete line of agricultural and industrial power machinery.

The United tractor is a modern, medium capacity tractor, combining good power with light weight and providing ready adaptability for all farming and industrial power needs. It is built by the Allis-Challis Manufacturing Company under contract for the United Tractor & Equipment Corporation.

Among the features claimed for the new United tractor are great power in proportion to weight, high flexibility, modern automotive design and low price. The automotive type transmission provides four speeds forward and one reverse.

The United tractor is powered by a 4-cyl. 40-hp. engine of special Continental design. The motor is of the L-head type, with a cylinder bore of 4¼ in. and 5 in. piston stroke. Displacement is 284 cu. in. Under full load, the motor speed is 1200 r.p.m. and is under built-in governor control. The engine is equipped with an air cleaner of the centrifugal and oil cleaner type, and oil purolater, gasoline filter, oil pump and full pressure lubricating system, in-built variable speed governor and water pump.

The differential is of the 4-pinion type and is mounted on Timken roller bearings. A live rear axle mounted in Hyatt roller bearings is employed. All transmission gears, differential and rear axle are enclosed in a heavy cast housing which serves as the foundation or body of the tractor.

The United tractor is compact in design and light in weight for a tractor of its capacity. The net weight is 3,900 pounds without water, fuel or special equipment. The overall length is 118½ in., overall width 63 in., height overall 53¼ in. Although the United tractor is low hung, its construction provides standard clearance.

Prestolith Velo Cement Announced

Anticipation of the demand for speed and safety in concrete construction has been the guiding motive in the Missouri Portland Cement Company's program of expansion.

The new modern plant built by the Missouri Portland Cement Company, St. Louis, Mo., was constructed solely for the manufacture of Prestolith Velo cement to supply to the great demand for quick setting cements. Speed and safety are combined in Prestolith Velo cement concrete which is claimed to attain in 24 hours the strength required of normal Portland cement concrete in 28 days.

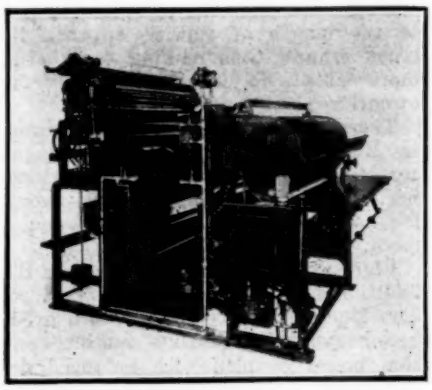
This is stated to be the first plant to be built by any manufacturer for the exclusive production of high-early strength cement, it is claimed.

Prestolith Velo cement has normal initial and final setting time, is extremely workable when used in reinforcing and uses less water than normal portland cement. These attributes are invaluable in this day of speed, when construction must step along at the double-quick.

A pavement, constructed with Prestolith Velo cement concrete, can be laid today and in 24 hours is ready for full traffic, according to the manufacturer.

Pease Develops New Blue-Printing Machine

Speed of production, high quality prints, and low operating cost are outstanding features claimed for the new Pease "Peerless" Model 30 Blue-Printing Equipment as announced by the C.



Pease "Peerless" Produces Blue-Prints, Negative Prints, Blue Line and Brown Line Prints in Continuous Operation

F. Pease Company, North Franklin Street, Chicago, Illinois.

This new "Peerless" Model 30 continuous blue-printing equipment is stated to combine all the best mechanical features developed after long research in perfecting blue-printing machinery. The Model 30 will produce excellent blue-prints, negative prints, and blue line and brown line prints and, while somewhat the same in operation as the present original Pease "Peerless" Model 20 blue-printing machine, the new Model 30 differs radically as to design in many respects.

While the new Pease "Peerless" Model 30 continuous blue-printing machine has a maximum production of 12 linear ft. per minute and is particularly adapted to long run, high speed production, single prints can be handled equally as well and just as economically on this new machine. As a matter of fact, Model 30 printer can be operated separately from the washing and drying machine by means of a simple clutch adjustment and can also be purchased separately if desired. The Model 30 is made in two sizes, 42 in. and 54 in. widths, either 110 or 220 volts DC. or 220 volts AC. The 42 in. machine is equipped with six lamps and the 54 in. machine is equipped with seven lamps. These lamps are of the special Type P enclosed arc style and consume either 6½ amperes on DC. or 7½ amperes on AC. when adjusted for their most effective printing speed.

Further information on the new Model 30 is contained in a special brochure and a copy of this booklet can be obtained without obligation upon request to the C. F. Pease Company, 813 North Franklin Street, Chicago, Illinois.